AQUATIC RESOURCES INVENTORY OF THE MT. HAGGIN AREA

Richard A. Oswald

Montana Department of Fish, Wildlife and Parks

Project Number 3323

Region Three

Bozeman, Montana

1981

ACKNOWLEDGEMENT

Able assistance in the collection of field data was provided by Tom Greason, George Liknes, Fran Fitzgerald and Mike Vaughn. Fred Nelson and Bob McFarland provided the computer analyses of the wetted perimeter data. The wetted perimeter-discharge figures were prepared by Wayne Black. The manuscript was typed by Jan Hughes.

TABLE OF CONTENTS

Table of Contents Cont.

LIST OF TABLES

List of Tables Continued.

Appendix

LIST OF FIGURES

ABSTRACT

An inventory of the aquatic resources of the Mount Haggin Wildlife Management Area was conducted during the summer of 1980. The inventory consisted of 1) a water quality study, 2) a fisheries survey and, 3) a water availability and instream flow recommendation study. Work was concentrated on 13 major streams.

The Mount Haggin streams generally exhibited good water quality and were classified into two basic types on the basis of chemical enrichment and stream origin. Some potential water quality problems were identified and included sediment, mercury, lead and arsenic.

The studied streams were found to contain high populations of "pan-sized" trout. Estimated populations in stream study sections ranged from 160 to 740 trout per 1,000 feet. Catchable sized fish comprised 9 to 63% of the populations. Brook trout were the most numerous and widely distributed gamefish at Mount Haggin. Other gamefish collected included rainbow trout, cutthroat trout, rainbow X cutthroat hybrid trout, mountain whitefish and burbot. Non-game species present included mottled sculpin, longnose sucker and longnose dace.

The wetted perimeter method of determining instream flows was applied to eleven Mount Haggin streams. A minimum flow recommendation for the preservation of fish and wildlife habitat was made for each stream for the low flow period. Minimum flow recommendations were made for two other Mount Haggin streams under a different project.

INTRODUCTION

In 1976, the Montana Department of Fish, Wildlife and Parks (MDFWP) acquired the Mount Haggin Wildlife Management Area through the Nature Conservancy. The 55,000 acre tract had been owned by the Mount Haggin Livestock Company and was primarily used for the grazing of livestock. The area, which lies about ten miles southeast of Anaconda, has historically been an important hunting and fishing resource for local residents. Access to the Mount Haggin Area is provided by Montana Highway 274 which roughly bisects the property from north to south.

The Mount Haggin area is situated on the eastern flanks of the Anaconda-Pintlar range and is partitioned into east and west slope drainages by the Continental Divide. The area is characterized by a variety of topographical features and habitat types encompassing an elevational range of approximately 9,000 to 5,500 feet. Coniferous forests of lodgepole pine and douglas fir dominate the upper slopes and ridges while whitebark pine, alpine fir, spruce and aspen contribute to a lesser extent to the forest habitat. The lower foothills are primarily grasslands dissected by numerous streams and willow bottom riparian zones.

Mount Haggin was acquired by the MDFWP for the management of dispersed outdoor recreation. Anticipated activities include backpacking, hiking, hunting, fishing, ski touring and snowmobiling. The management of these activities is to be consistent with the area's ability to support such use and with a policy of returning the lands to a natural environment. A grazing lease with the Mount Haggin Livestock Company and a timber sale contract with the Louisiana Pacific Corporation were included under the purchase agreement. These contracts are in effect at the present time.

The Mount Haggin interim management plan of the MDFWP calls for a resource inventory of the area. Inventories of archeological, (Smith, 1979) historical, (Newell, 1980) and wildlife (Erickson, 1979 and Frisina, 1980) resources have been completed. This report will address aspects of the Mount Haggin fisheries resource including: 1) a waterquality inventory, 2) a fish populations survey, and 3) a water use and flow reservation study. This phase of the fisheries resource inventory is consistent with the Mount Haggin interim management plan for the 1980 field season.

Water Quality Inventory

Introduction

A water quality inventory was initiated to characterize the current status of streams on the Mount Haggin Management area. The measurement of physical and chemical parameters will also provide a baseline to monitor current land uses such as cattle grazing, timber harvest and future land use changes.

Methods

Water samples were collected at high (June 10-17, 1980), intermediate (July 8-10, 1980) and low flows (August 26 - September 2, 1980) at stations on 13 Mount Haggin streams (Figure 1). Samples were collected by immersing a DH-48 depth integrated sampler at approximately one foot intervals throughout a stream cross section. A sample collection consisted of: 500 ml untreated, 250 ml filtered, 500 ml filtered and acidified, 500 ml acidified, 250 ml treated with 1% $HgCl_2$, and 250 ml for sediment analysis from each stream on each sample date. Chemical samples that were not acid preserved were kept on ice in the field and refrigerated as soon as possible. After collection, the samples were delivered to the Analytical Division of the Montana Bureau of Mines and Geology in Butte for analysis by standard methods.

Chemical parameters selected for analysis included: specific conductance, alkalinity, hardness, pH, total sediment, major anions and cations and nitrate. Also included in the analysis were determinations of dissolved arsenic at high and low flows and heavy metals analyses at low flow on streams that had a past mining history. Streams from which chemical samples were collected include: Seymour, Sullivan, Twelvemile, Slaughterhouse, Tenmile, Sevenmile, Deep, Sixmile, Oregon, American, California, French and Willow Creeks.

Results

Selected chemical and physical parameters for Mount Haggin streams are presented in Table 1 and Appendix Table 1. The data indicate that Mount Haggin streams exhibit low to intermediate specific conductances and alkalinities and nearly neutral to slightly basic pH values. Streams that originate at high elevation along the north-south spine of the Anaconda-Pintlars, (e.g. Seymour, Sullivan, Twelvemile and Tenmile Creeks), exhibited very low specific conductances ($\bar{x}$ = 35.7 to 64.0 umhos /cm), while streams originating at lower elevation, (e.g. Sevenmile, Slaughterhouse, Sixmile and Willow Creeks) showed intermediate conductance values ($\bar{x}$ = 96.0 to 235.9 umhos/cm). Total alkalinities followed this same trend of stream origin. The alkalinity of all Mount Haggin streams was bicarbonate in nature with the exception of the intermediate flow of Sevenmile Creek which contained some carbonate alkalinity. Specific conductance, alkalinity and pH all increased with decreasing flow in the Mount Haggin streams.

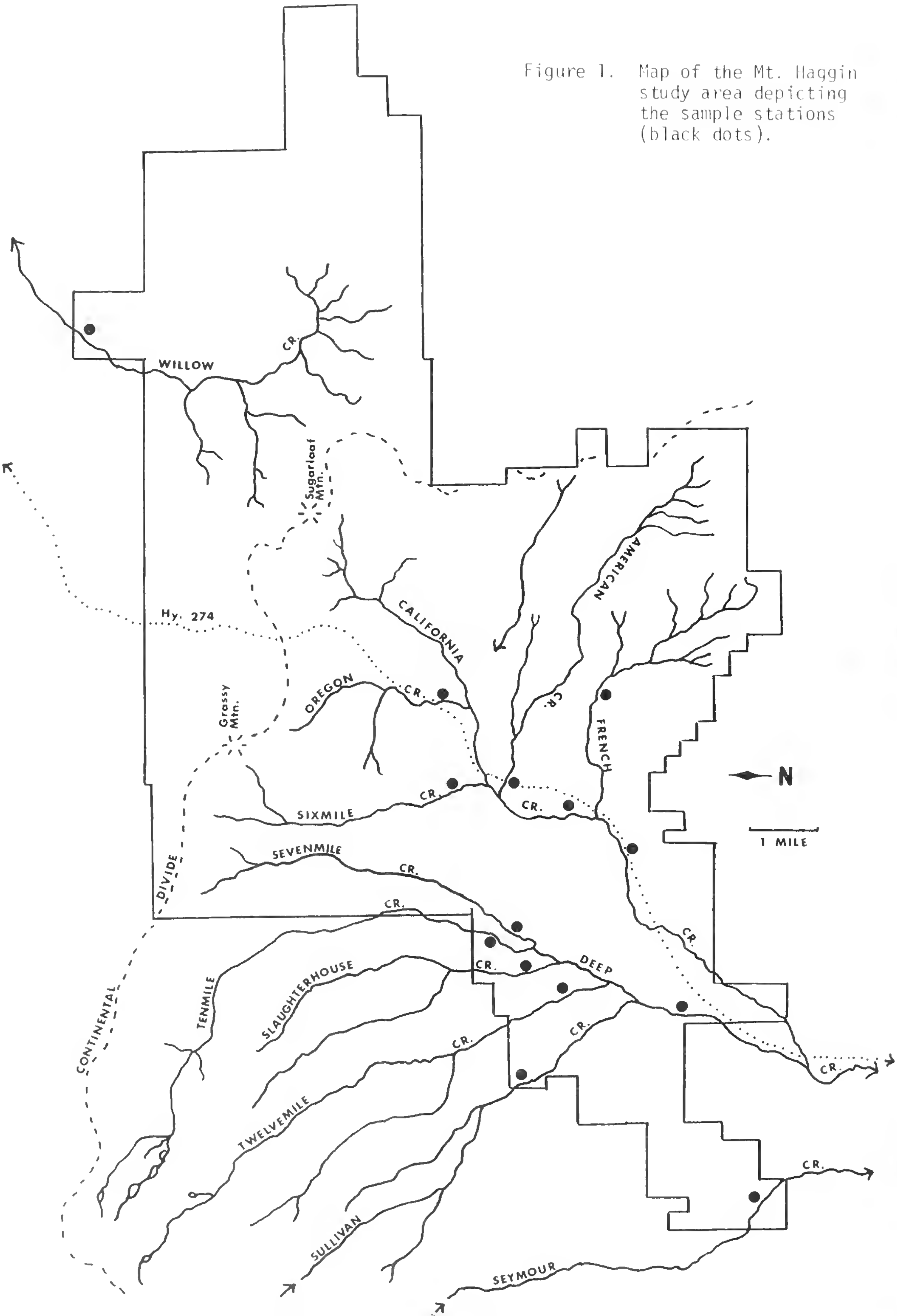


Figure 1. Map of the Mt. Haggin study area depicting the sample stations (black dots).

Table 1. Average concentrations* of selected chemical and physical parameters measured in Mt. Haggin streams at high, intermediate and low flows.

	Seymour Creek	Sullivan Creek	Twelvemile Creek	Slaughterhouse Creek	Tenmile Creek
Conductance	55.5	64.0	35.7	171.9	41.0
Alkalinity	23.24	21.95	12.47	82.37	15.80
Hardness	24.81	28.42	14.06	85.38	17.37
pH	7.34	7.18	6.94	7.69	7.02
Sediment	16.3	8.4	2.0	3.6	4.5
Ca	8.1	7.9	4.4	23.7	5.2
Mg	1.1	2.1	0.8	6.4	1.1
Na	1.8	1.8	2.0	3.6	2.1
K	0.9	0.6	0.5	0.8	<0.04
Fe	0.07	0.39	0.18	0.19	0.11
Mn	<0.01	0.02	0.02	<0.01	<0.01
SiO_2	11.0	10.9	11.4	18.1	10.0
HCO_3	28.3	26.8	15.2	100.4	19.3
CO_3	-	-	-	-	-
SO_4	4.2	7.3	3.5	6.8	4.2
Cl	0.4	0.6	0.6	0.5	0.5
NO_3	0.23	0.12	0.11	0.85	0.03
F	0.27	0.30	0.26	0.13	0.23
Total Fe	0.10	0.60	0.27	0.30	0.16
Total Mn	<0.01	0.03	0.02	0.05	0.01

*Concentrations in mgl/l except conductance (umhos/cm)

Table 1. continued.

	Sevenmile Creek	Deep Creek	Sixmile Creek	Oregon Creek	American Creek
Conductance	235.9	73.0	204.0	96.0	117.0
Alkalinity	131.93	30.37	91.91	35.46	52.85
Hardness	136.61	33.22	99.24	37.84	56.86
pH	8.11	7.33	8.00	7.39	7.66
Sediment	6.1	8.5	7.8	12.7	2.9
Ca	39.4	9.6	32.6	11.2	15.3
Mg	5.5	2.3	4.3	2.4	4.5
Na	2.6	2.2	2.0	5.2	1.7
K	0.8	0.7	0.8	1.3	1.4
Fe	0.16	0.27	0.11	0.15	0.10
Mn	0.01	0.02	0.01	0.02	0.01
SiO_2	15.2	12.0	12.2	18.9	12.4
HCO_3	159.2	37.0	112.1	43.2	64.4
CO_3	0.3	-	-	-	-
SO_4	7.0	4.8	9.3	10.9	6.0
Cl	0.5	0.4	0.7	0.5	0.4
NO_3	0.78	0.20	0.14	0.08	0.04
F	0.25	0.27	0.21	0.18	0.11
Total Fe	0.36	0.39	0.18	0.25	0.17
Total Mn	0.03	0.02	0.02	0.02	<0.01

Table 1. Continued.

	California Creek	French Creek	Willow Creek
Conductance	145.1	136.3	142.7
Alkalinity	61.54	53.37	45.25
Hardness	65.39	56.68	51.20
pH	7.71	7.69	7.49
Sediment	82.8	37.4	5.6
Ca	18.9	16.4	16.8
Mg	4.4	3.8	2.3
Na	3.3	3.5	7.4
K	2.0	1.4	1.5
Fe	0.16	0.12	0.12
Mn	<0.01	<0.01	0.02
SiO_2	15.5	17.8	25.8
HCO_3	75.0	65.1	55.2
CO_3	-	-	-
SO_4	9.6	9.8	19.9
Cl	0.5	0.5	0.9
NO_3	0.11	0.22	0.05
F	0.20	0.14	0.14
Total Fe	2.33	0.76	0.26
Total Mn	0.12	0.03	0.03

*Concentrations in mg/l except conductance (umhos/cm)

The Mount Haggin waters are primarily soft water streams. Slaughterhouse, Sevenmile and Sixmile Creeks are exceptions and exhibited hard water in the moderate range. Calculation of Ryznar stability and Langelier Saturation Indeces indicate that most Mount Haggin waters are corrosive, rather than scale-forming, in nature. Water hardness increased with decreasing discharge.

The Mount Haggin streams are calcium-magnesium-bicarbonate or calcium-sodium-bicarbonate waters. Concentration of component anions and cations were extremely low in the streams that originated at high elevations. The major dissolved component following bicarbonate in the streams was silica. Ionic concentrations achieved much higher levels in the streams that originated at lower elevation.

Concentration of individual cations increased as discharge decreased on all Mount Haggin streams. This same trend was observed during a study of the Big Hole River (Bahls, 1978). The dominant cation in all streams was calcium ($\bar{x}$ = 4.4 to 39.4 mg/l) followed by magnesium or sodium.

With the exception of the bicarbonate ion, concentration of anions did not increase as discharge decreased. Sulphate, chloride and fluoride ions generally decreased in concentration as the flow decreased. In some cases, a slight increase in concentration was noted between the intermediate and low flows; however, the highest concentrations of these ions were found at the high flow sample. Still another pattern was observed in concentration of nitrate. Nitrates generally reached maximum concentration at the intermediate flow sample and minimum concentration at low flow. Bicarbonate was the dominant anion in all of the studied streams followed by sulphate.

Total sediment levels were extremely low in most cases in Mount Haggin streams. Heavy concentrations of sediment were measured in California Creek (235.8 mg/l) and French Creek (98.3 mg/l) at the intermediate flow following a rainstorm. High concentrations of total recoverable iron also accompanied these sediment increases. Similar concentrations were not measured in other Mount Haggin streams.

Arsenic concentrations were measured at high and low flow in all of the studied streams (Table 2). Concentrations of arsenic generally increased as stream origin moved from the southwest to the northeast and with the proximity of the stream headwaters to the Anaconda Smelter (Figure 2). Mean arsenic concentration ranged from 1.1 ug/l in Seymour Creek to 33.4 ug/l in Willow Creek. Concentration increased between the high and low flows in all studied streams except Oregon Creek.

Table 2. Arsenic concentrations (ug/l) measured at high and low flows in Mount Haggin streams.

	High Flow	Low Flow	Average
Seymour Creek	0.8	1.3	1.1
Sullivan Creek	1.5	2.2	1.9
Twelvemile Creek	1.7	2.6	2.2
Slaughterhouse Creek	5.2	5.4	5.3
Tenmile Creek	1.9	2.9	2.4
Sevenmile Creek	6.7	8.3	7.5
Deep Creek	3.3	4.7	4.0
Sixmile Creek	7.0	7.3	7.2
Oregon Creek	29.5	20.3	24.9
American Creek	7.6	10.7	9.2
California Creek	17.0	20.5	18.8
French Creek	14.3	18.4	16.4
*French Creek II	-	20.3	-
Willow Creek	26.1	40.6	33.4

*Sample collected above the mouth of California Creek in French Gulch at low flow.

A heavy metals analysis was performed on the low flow samples from three Mount Haggin streams because of their past mining histories (Table 3). Dissolved copper, mercury, lead and zinc were measured in Oregon, California and two stations on French Creek. Metal concentrations were generally low with the exception of lead in Oregon Creek (.08 mg/l) and mercury in California Creek (.04 ug/l).

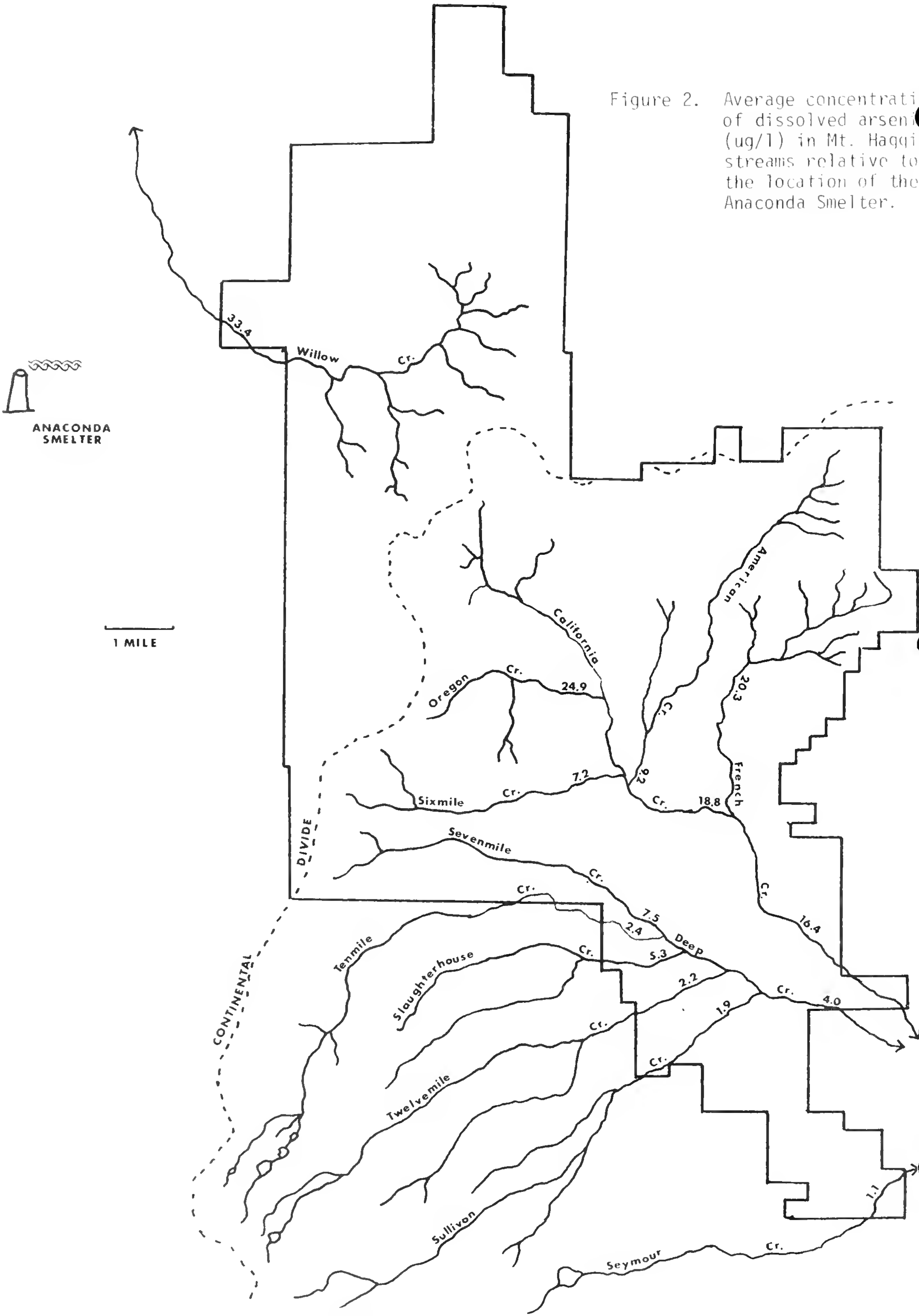


Figure 2. Average concentrations of dissolved arsenic (ug/l) in Mt. Haggin streams relative to the location of the Anaconda Smelter.

Table 3. Concentrations of selected heavy metals measured at low flow in Mount Haggin streams with past mining histories.

	Oregon Creek	California Creek	French Creek
Cu	<.01	<.01	.01
*Hg	<.03	.04	<.03
Pb	.08	<.04	<.04
Zn	<.01	<.01	<.01

*Hg concentrations in ug/l, others in mg/l.

Discussion

The chemical composition of the water of small streams is a product of precipitation, surface runoff, geology of drainage basins and complex chemicalinteractions within the stream itself (Reid and Wood, 1976). Human activities on or near streams often introduce other variables into the final determination of water chemistry while human demands on streams as consumptive and recreational resources require specific water quality criteria.

Water quality in Mount Haggin streams was generally found to be good to excellent. Some areas of concern were detected and these will be discussed later.

a) Stream Typology

Two distinct water quality patterns are identifiable in the Mount Haggin streams. The streams that originate at high elevations along the north-south spine of the Anaconda-Pintlars are marked by very low amounts of dissolved chemical constituents and excellent water quality. This pattern of chemical sterility is consistent with other streams in the upper Big Hole drainage (USFS, unpublished data). This group of streams includes Seymour, Sullivan, Twelvemile, Tenmile and Deep Creeks. Deep Creek was included in this group because its chemistry is reflective of the high altitude streams which are its major tributaries. These streams are characterized by low concentrations of dissolved solids, soft water and high percent contributions of silica. This pattern is typical of high elevation streams which drain youthful mountain ranges (Reid and Wood, 1976).

The relative lack of chemical enrichment in these high elevation streams is due to a predominance of Belt rocks in the headwater areas (USFS, unpublished data). The Belt rocks are composed of very old metasediments which are extremely resistent to chemical and mechanical weathering.

Total alkalinity levels were often near or below the recommended minimum of 20 mg/l (USEPA, 1976). In cases where natural concentrations are less than 20 mg/l, it is recommended that they should not be reduced.

The Mount Haggin streams that originate at lower elevations along the eastern foothills of the Anaconda-Pintlars are marked by intermediate to high levels of dissolved chemical constituents and good water quality. This stream type includes Slaughterhouse, Sevenmile, Sixmile, Oregon, American, California, French and Willow Creeks. Specific conductance and total alkalinity were much higher than in the high elevation streams. Silica composed a relatively low percentage of the dissolved solids and was dominated by calcium in most cases. This elevation in dissolved solids and decrease in the importance of silica is typical of valley or lowland streams in youthful mountain ranges (Reid and Wood, 1976).

The higher chemical enrichment of these lower elevation streams can be traced to a mixture of geologic formations. The lower drainages are predominated by glacial outwash which contains a mixture of rock types (USFS unpublished data). Glacial outwash weathers easily and can produce large amounts of dissolved solids into streams. Tertiary volcanics, Cretaceous intrusives and Paleozoic sediments are also present and can contribute to the chemical composition of these streams.

b) Patterns of Concentration

Concentrations of dissolved solids in natural waters generally tend to increase with decreasing discharge (Hynes, 1970). The major cations, bicarbonate, silica, specific conductance, alkalinity, hardness and pH all followed this pattern at Mount Haggin. This is indicative of relatively constant ground water sources for these components which concentrate with the decreasing dilution factor.

Sulphate, chloride and fluoride ions did not concentrate as flow decreased in Mount Haggin streams. These anions reached maximum levels at the high flow and generally tended to decrease in concentration with decreasing discharge. This is indicative of more diffuse sources for these ions which could include decomposition of organic materials, precipitation and sorbed surface particles (Hynes 1970, Ruttner 1963). Surface runoff, rather than groundwater is the probable major source of these components in the Mount Haggin streams. Sulphate and chloride were found to increase with decreasing flow in the Big Hole River (Bahls, 1978).

Nitrate concentrations exhibited still another pattern of concentration in the Mount Haggin streams. The highest concentrations of nitrate were measured at intermediate flow while trace concentrations were found at the low flow sample in most cases. Nitrate usually becomes available to streams via precipitation and decomposition of organic debris (Hynes 1970, Reid and Wood, 1976). The major source, then, is runoff. Nitrates generally reach maximum concentrations during the spring runoff and decrease rapidly as they are taken up by plants as discharge decreases (Reid and Wood, 1976). Bahls (1978) observed maximum nitrate concentrations in June and the lowest concentrations in early July in the Big Hole River. He believed that nitrogen became the limiting factor for primary production after July. The deviation of the Mount Haggin streams from this pattern may be due to several causes.

The elevation of the Mount Haggin streams may cause a lag in the development of periphyton communities which would take up nitrates. Secondly, the presence of numerous beaver ponds may act as a system of nitrate storage reservoirs which are capable of collecting and delaying the release of runoff nitrates and organic source materials. Finally, the intermediate flow period may have been marked by the presence of communities of nitrogen fixing blue-green algae. Extremely high nitrate concentrations in Slaughterhouse and Sevenmile Creeks were accompanied by large skeins of filamentous algae.

c) Metals

Although the data indicate good to excellent water quality in the Mount Haggin streams, some areas of concern were noted. Relatively high arsenic levels were measured in Oregon, California, French and Willow Creeks. Arsenic distribution patterns (Figure 2) indicated that the arsenic concentrations may be due to precipitates from the Anaconda Smelter, or, in the case of French Creek, past mining activities. Arsenic is concentrated by aquatic organisms, however, the concentration is not progressive through the food chain. Toxicity of arsenic varies with the valence of the ions with the trivalent arsenicals being more toxic than the pentavalent. Arsenic concentrations in Mount Haggin streams were well below any known values capable of harming aquatic life; however, arsenic has been found to have a greater toxic effect on mammals than on aquatic organisms (USEPA, 1976). A low flow concentration of 40.6 ug/l in Willow Creek approaches the EPA criterion of 50 ug/l for drinking water. While present arsenic levels in the Mount Haggin streams are not at known toxic concentrations, they should be monitored to prevent future damage to fish and wildlife.

A heavy metals analysis was performed on the low flow samples from Oregon, California and French Creeks because of their past mining histories. Concentrations of dissolved copper, mercury, lead and zinc were low or below minimum detection levels in most cases. Exceptions were noted for lead in Oregon Creek and mercury in California Creek. A low flow concentration of .08 mg/l of lead was observed in Oregon Creek. This concentration exceeds both the mean natural range of lead in rivers and streams (1-10 ug/l) and the domestic water supply standard (50 ug/l) recommended by the EPA. Two to three month exposures of brook and rainbow trout to .1 mg/l lead in soft water (20-45 mg/l $CaCO_3$) resulted in detrimental effects on the fish (USEPA, 1976). The solubility and hence, the toxicity potential of lead increase markedly with water softness; therefore, conditions in Oregon Creek may be near to a point at which damage could occur to the trout population. It is not known whether the lead concentrations in Oregon Creek originate from natural sources, from air-born precipitates, or from past mining operations on the stream. Lead concentrations downstream in California Creek did not indicate any detrimental effects contributed from Oregon Creek.

The mercury concentration in California Creek was observed to be .04 ug/l at low flow. This amount falls within concentrations measured in U.S. rivers from 31 states where no known mercury deposits occurred (<.1 ug/l); however, it approaches the maximum standard of .05 ug/l recommended for the protection of aquatic life by the EPA (USEPA, 1976). Mercury can be

progressively concentrated through the food chain and is most toxic in its methylated form. Certain micro-organisms have the ability to methylate mercury in the natural environment, therefore, it is recommended that total mercury levels rather than one particular form be the basis for a mercury criterion. It has been observed that over a period of 20-48 weeks, several species of fish had the ability to accummulate more than .5 ug/g of mercury in tissues from aquatic concentrations of methyl mercury as low as .018 to .030 ug/l(USEPA, 1976). Mercury concentrations in California Creek may represent a potential threat to fish populations if methylating conditions are present. It is not known whether the mercury is present from natural or man-caused sources such as mining activity.

Concentrations of copper and zinc in Oregon, California and French Creeks were found to be at very low or trace levels. In general, dissolved heavy metal concentrations in the three streams do not appear to pose an immediate threat to fish populations. No sediment chemistry analyses were performed on the Mount Haggin streams. It has been found that sediments in a heavily mined area of Grasshopper Creek, Montana contained very high levels of heavy metals while water samples showed low levels of the dissolved forms of the same constituents (Peterson, 1979). This reach of Grasshopper Creek was observed to support depressed populations of trout and aquatic invertebrates. It is possible that the sediments of Oregon, California and French Creeks contain elevated levels of heavy metals and may represent a further threat to fish populations. Another ramification of heavy metals concentrations exists because of the soft water of the Mount Haggin streams. Some metals, especially copper and lead, become more soluable and more toxic in soft water. For this reason, heavy metals must be regarded as a potential threat to fisheries in some Mount Haggin streams.

d) Sediments

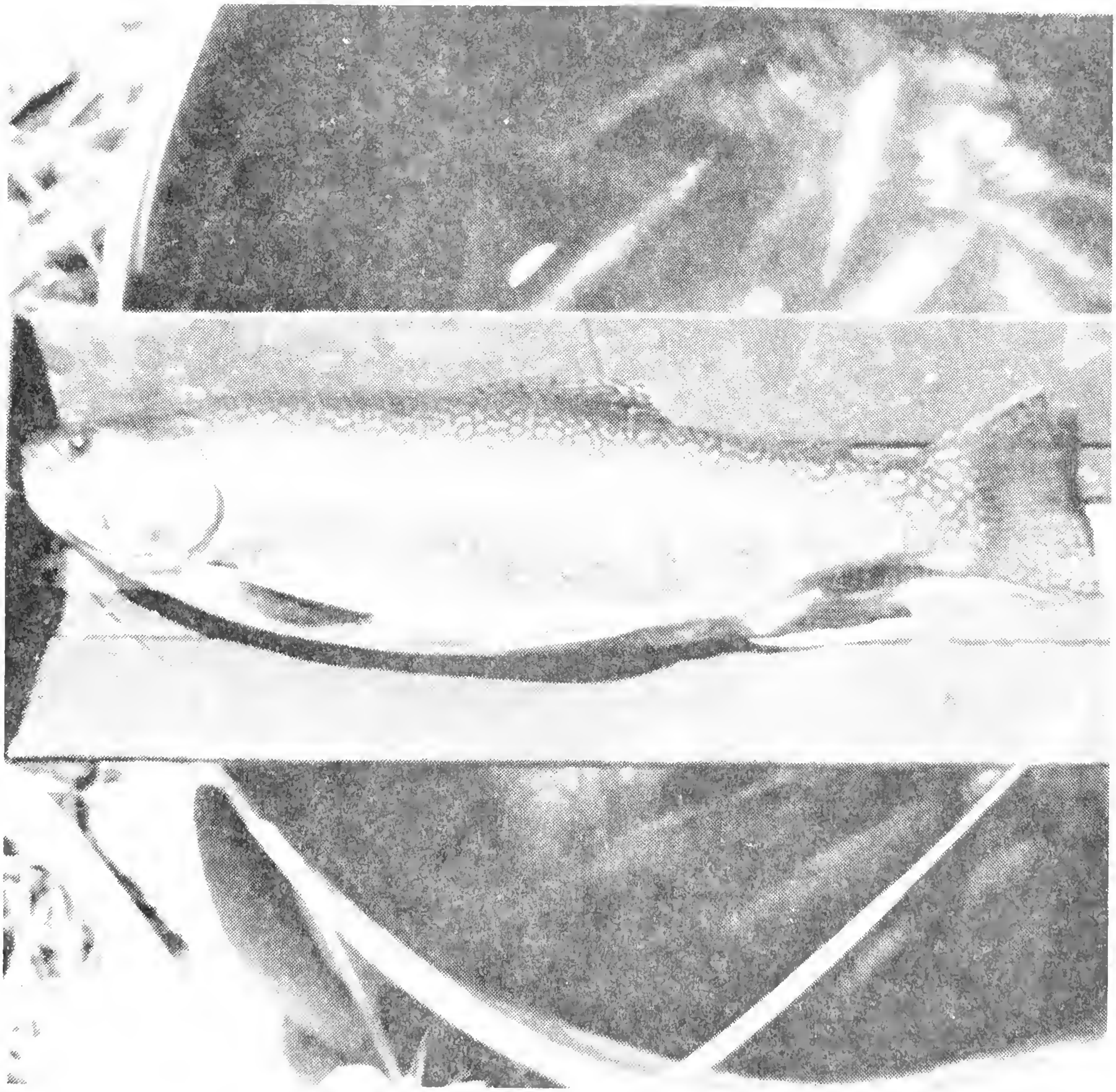
Most of the Mount Haggin streams were found to carry very small loads of suspended sediment despite the occurrance of intensive logging activity in the surrounding areas. This may be due to the presence of numerous beaver ponds which act as sediment traps. High levels of a milky gray sediment were measured in California and French Creeks on the day after a rain shower during the intermediate flow period. Much lower amounts of the sediment were observed in Willow Creek two days after the rain. The sediment originates on the slopes near Sugarloaf Mountain which hold tributaries of California and Willow Creeks. California Creek is the main tributary of French Creek. These slopes are poorly vegetated and exhibit large areas of eroded gray soils. The area has had a past history of heavy logging, grazing, fires and damage to vegetation from arsenic and sulphide precipitates from the Anaconda Smelter. These factors have combined to produce the poorly vegetated erodable slopes in the area.

Numerous studies have shown that sediments can be extremely detrimental to the aquatic ecosystem. Some major effects of sedimentation are loss of spawning gravels or actual smothering of fish eggs and loss of benthic food organism via the filling of gravel interstices. Sediment levels as low as 80 mg/l have been found to decrease standing crops of macroinvertebrates by 60 percent both in areas where the sediment was suspended and where it had

settled out. Sediment levels measured in California and French Creek have the potential to harm the habitat of these streams especially under circumstances of frequent or prolonged precipitation near Sugarloaf Mountain.

A secondary result of the sediment loads produced into California and French Creeks was an elevation in the amount of total recoverable iron. Total iron concentration reached 6.5 mg/l in California Creek and 1.7 mg/l in French Creek. These values represent a 650 and 100 percent increase over the highest level of total iron measured in any other sample. Levels of dissolved iron, which can be toxic to aquatic organisms at low concentrations (1.0 mg/l) did not increase appreciably at this time. This is due to the low solubility of iron under the aerobic conditions found in streams. Precipitated compounds of ferric (oxidized) iron, however, have been found to be detrimental to fish populations both as suspended flocs and settled materials on stream bottoms (USEPA, 1976). Ferric hydroxide precipitates have been found to coat fish gills, smother fish eggs and reduce communities of benthic invertebrates and periphyton.

Sediment and iron loads produced into California and French Creeks represent threats to the aquatic habitat potential. These streams supported the lowest estimated trout populations among all of the streams that were surveyed on the Mount Haggin area.



FISHERIES INVENTORY

A fisheries inventory was initiated to assess the current species composition and fish populations of streams on the Mount Haggin area. This information can be used to characterize the current status of the fishery and provide a basis of comparison for the effects of future habitat improvement or impairments and fisherman use.

Methods

Fish population estimates and species composition were determined in 1,000 foot study sections on each of twelve Mount Haggin streams including: Seymour, Sullivan, Twelvemile, Slaughterhouse, Tenmile, Sevenmile, Deep, Sixmile, Oregon, American, California and Willow Creeks (Figure 1). Fisheries data from French Creek were collected in 1979 by Janet Decker-Hess of the MDFWP and will be included in this report.

Fish populations were sampled by using a bank electrofishing unit consisting of a 110 volt Honda generator, a Fisher shocker box, a 500 foot cord, a stationary negative electrode and a mobile positive electrode. D.C. current was used to draw fish to the positive electrode where they were netted.

Two sampling runs were made through each study section. During the first run, captured fish were anesthetized, weighed, measured and marked with a partial fin clip, usually on the anal fin. Scale samples were also collected from each fish for age determination. After a time period of approximately two weeks, a second electrofishing run was made through each study section. During the second run, lengths, weights and scale samples were collected from each unmarked fish and lengths were measured on marked fish.

Standing crop estimates of numbers of fish were calculated by using a modification of the basic formula:

$$P = \frac{MC}{R}$$

where: P= estimated number of fish
M= number initially marked
C= total number of fish collected in recapture run
R= number of marked fish collected in recapture run

Computer analysis allows the calculation of standing crops by 1/2 inch group, length group (size groups of similar recapture efficiency), age group and weight and provides for statistical analysis of the data. Coefficients of condition, mean weight by length group, mean length by age group and recapture efficiencies are also provided by the computer program developed by the MDFWP. Electrofishing and estimate methods used during the study are discussed by Vincent (1971 and 1974).

Results

a) Species Composition

The Mount Haggin streams supported a relatively diverse composition of fish species for high altitude streams (Table 4). The brook trout (*Salvelinus fontinlis*) was the dominant game fish and was present in all 13 streams that were studied. Rainbow trout (*Salmo gairdneri*) were common and found in most of the streams. Cutthroat trout (*Salmo clarki*) and rainbow-cutthroat hybrid composed the remainder of the trout species collected. Cutthroat trout collections were limited to Willow and Sixmile Creeks. Other game fish that were present included mountain whitefish (*Prosopium williamsoni*) and burbot (*Lota lota*). Non-game species collected included mottled sculpin (*Cottus bairdi*), longnose sucker (*Catostomus catostomus*) and longnose dace (*Rhinichthys cataractae*).

b) Fish Populations

The numerical composition of the fish population of each study section is given by species and length range in Appendix Table 2. Sculpins and dace were not counted, nor were any lengths or weights measured, and are merely listed as present in each stream in which they were collected. Data presented in this table clearly indicate that the brook trout is the dominant fish species. Rainbow trout, while present in many of the streams, were captured in low numbers. Cutthroat trout were present in low numbers in the Sixmile Creek section and relatively high numbers in Willow Creek. Mountain whitefish, burbot, longnose suckers and longnose dace were found to be most abundant in larger streams such as Deep, French and California Creeks. Mottled sculpin were common in all of the study sections.

Estimates of standing crop (numbers and biomass) were calculated for brook, rainbow or cutthroat trout populations where sufficient numbers of these species were captured to insure statistical reliability of the estimate. Estimated standing crops of fish by length group are presented in Appendix Table 3. Some of this data is summarized to include total estimates of trout and individual trout species for each Mount Haggin stream study section in Table 5. Trout populations ranged from a low of 160 per 1,000 feet in California Creek to a high of 740 per 1,000 feet in Willow Creek.

Table 4. Distribution of fish species among streams on the Mount Haggin area in 1980.

Stream	SPECIES								
	Brook Trout	Rainbow Trout	Cutthroat Trout	Rainbow X Cutthroat Trout	Mountain Whitefish	Burbot	Longnose Sucker	Longnose Dace	Mottled Sculpin
Seymour Creek	X	-	-	-	-	-	-	-	X
Sullivan Creek	X	-	-	-	-	-	-	-	X
Twelvemile Creek	X	-	-	X	-	-	-	-	X
Slaughterhouse Cr.	X	X	-	-	-	-	X	-	X
Tenmile Creek	X	X	-	-	-	X	-	-	X
Sevenmile Creek	X	X	-	X	-	-	X	-	X
Deep Creek	X	X	-	-	X	X	X	X	X
Sixmile Creek	X	X	X	X	-	-	-	-	X
Oregon Creek	X	X	-	-	-	-	-	-	X
American Creek	X	X	-	X	-	-	-	-	X
California Cr.	X	X	-	-	X	X	X	X	X
*French Creek	X	X	-	-	X	X	X	X	X
Willow Creek	X	-	X	-	-	-	X	-	X

*From MDFWP Collection, Janet Decker-Hess, 1979.

Table 5. Estimated standing crops of trout in 1,000 ft. study sections of Mount Haggin streams (P denotes presence in numbers too low to make a reliable estimate).

	Brook Trout		Rainbow Trout		Cutthroat Trout		Total Trout	
	Number	Pounds	Number	Pounds	Number	Pounds	Number	Pounds
Seymour	519	41	-	-	-	-	519	41
Sullivan	602	29	-	-	-	-	602	29
Twelvemile	314	27	-	-	-	-	314	27
Slaughterhouse	182	19	P	-	-	-	182	19
Tenmile	353	31	P	-	-	-	353	31
Sevenmile	183	13	P	-	-	-	183	13
Deep	166	18	18	3	-	-	184	21
Sixmile	392	13	20	1	P	-	412	14
Oregon	265	24	P	-	-	-	265	24
American	160	12	8	1	-	-	168	13
California	130	16	30	3	-	-	160	19
*French	P	-	P	-	-	-	-	-
Willow	677	37	-	-	63	8	740	45

*From MDFWP collection, Janet Decker-Hess, 1979.

Trout numbers in French Creek were too low to make a reliable estimate. Estimated rainbow trout populations were low and ranged from 8 per 1,000 feet in American Creek to 30 per 1,000 feet in California Creek while populations of brook trout ranged from 130 per 1,000 feet in California Creek to 677 per 1,000 feet in Willow Creek. The Willow Creek section supported the only estimated cutthroat trout population at 63 per 1,000 feet.

Estimates of trout biomass ranged between 13 lbs/1,000 ft in Sevenmile and American Creeks and 45 lbs/1,000 ft in Willow Creek. Brook trout standing crops varied between 13 lbs/1,000 ft in Sevenmile and Sixmile Creeks and 41 lbs/1,000 ft in Seymour Creek. Brook trout biomass accounted for the vast majority of the standing crop in each study section.

Estimates given in Appendix Table 3 were calculated on the basis of length groups. The length groups are arrived at by lumping 1/2 inch groups with similar recapture efficiencies. Another way to look at the size distribution of the brook trout population is in terms of the numbers and percent contribution of catchable fish (6 inches and larger) within the population (Table 6). Numbers of catchable fish ranged between lows of 37 and 38 per 1,000 ft in Sixmile and American Creeks to a high of 173 per 1,000 ft in Seymour Creek and averaged 88 per 1,000 ft per stream. Percent contribution of catchable fish to total brook trout populations varied between 9 percent in Sixmile Creek and 63 percent in Deep Creek and averaged 32 percent for all of the study sections. The number of catchable cutthroat trout was estimated at 48 fish/1,000 ft and comprised 76 percent of the population in Willow Creek. Estimated numbers of catchable rainbow trout comprised 47 to 100 percent of the populations in American, California and Deep Creeks and only 15 percent of the population in Sixmile Creek.

Table 6. Estimated numbers and percentages of catchable fish (6 inches and larger) within the brook trout populations of Mount Haggin stream study sections.

	Number*	Percentage of Total Population
Seymour Creek	173	33
Sullivan Creek	70	12
Twelvemile Creek	109	35
Slaughterhouse Creek	77	42
Tenmile Creek	114	32
Sevenmile Creek	55	30
Deep Creek	104	63
Sixmile Creek	37	9
Oregon Creek	101	38
American Creek	38	24
California Creek	71	55
Willow Creek	106	16

*Number per 1,000 ft.

c) Condition

Fish condition is derived as a ratio between fish weight and length. It generally describes the "heft" or "fatness" of a fish at a given length or length range. Condition factors can be used to compare fish populations between streams and from different stations within the same stream. Mean condition factors for brook trout five inches long and larger are given in Table 7 for the Mount Haggin stream study sections. Brook trout condition ranged between a low of 37.89 in Deep Creek to a high of 43.04 in Tenmile Creek. The average condition factor for all Mount Haggin streams sampled in 1980 was 41.01. Rainbow trout conditions varied between 37.48 in American Creek and 46.56 in Sixmile Creek and averaged 41.38. Condition factors for cutthroat trout from Willow Creek averaged 38.55.

Table 7. Mean condition factors for estimated populations of trout five inches long and larger collected in the Mount Haggin stream study sections.

Stream	Brook Trout Condition Factor	Rainbow Trout Condition Factor	Cutthroat Trout Condition Factor
Seymour	40.71	-	-
Sullivan	41.08	-	-
Twelvemile	40.09	-	-
Slaughterhouse	41.86	-	-
Tenmile	43.04	-	-
Sevenmile	40.66	-	-
Deep	37.89	40.76	-
Sixmile	42.50	46.56	-
Oregon	42.53	-	-
American	39.09	37.48	-
California	42.98	40.71	-
*French	39.15	37.68	-
Willow	39.71	-	38.55

*MDFWP data collected by J. Decker-Hess 1979.

d) Age Structure

Trout population age structure was determined through the examination of scale samples collected from fish by 1/2 inch intervals. Estimates of the numbers of brook trout within different age groups are presented in Table 8.

Table 8. Estimated numbers* and percentages* (in parentheses) of brook trout within different age groups of populations surveyed in 1,000 ft study sections on Mount Haggin streams.

	Age Group				
Stream	0	I	II	III	IV+
Seymour Creek	-	228(44)	128(25)	145(28)	19(4)
Sullivan Creek	-	304(50)	161(27)	124(21)	14(2)
Twelvemile Creek	-	127(40)	111(35)	52(17)	24(8)
Slaughterhouse Creek	-	88(48)	53(29)	36(20)	6(3)
Tenmile Creek	-	141(40)	126(36)	67(19)	19(5)
Sevenmile Creek	-	93(51)	70(38)	15(8)	4(2)
Deep Creek	-	42(25)	84(50)	38(23)	3(2)
Sixmile Creek	259(66)	70(18)	28(7)	30(8)	5(1)
Oregon Creek	-	105(40)	99(37)	58(22)	3(1)
American Creek	-	57(36)	67(42)	30(19)	6(4)
California Creek	-	17(13)	58(45)	43(33)	12(9)
Willow Creek	-	267(39)	363(54)	40(6)	7(1)

*Rounded to the nearest whole number.

As would be expected in most populations, the greatest numbers of fish were found in the lower age groups (I and II) for most Mount Haggin streams. The only estimate of age 0 fish was made on Sixmile Creek where they comprised 66 percent of the populations. Age III and IV or older fish represented 25 percent or less of the brook trout population in all of the study sections except Seymour, California and Deep Creeks. Because of the low population numbers of rainbow trout in the studied streams, no estimates by age group will be treated in this report. The age structure of the Willow Creek cutthroat trout population was determined to be, 2 age I fish, 17 age II fish, 38 age III fish, and 6 age IV and older fish representing 3,27, 60, and 10 percent of the population, respectively.

The age data, when combined with mean length of the fish in each age group, can provide a rough means of comparing fish growth among the different Mount Haggin streams. Average lengths of brook trout by age group are presented in Table 9.

Table 9. Mean brook trout length (inches) at different age groups from 1,000 feet study sections on Mount Haggin streams.

	Age Group				
Stream	0	I	II	III	IV+
Seymour Creek	-	4.0	5.4	6.8	9.2
Sullivan Creek	-	3.4	4.7	5.8	8.2
Twelvemile Creek	-	4.0	5.6	7.3	8.9
Slaughterhouse Creek	-	4.7	6.4	7.8	9.0
Tenmile Creek	-	3.8	5.4	7.2	9.2
Sevenmile Creek	-	4.5	5.8	7.4	9.2
Deep Creek	-	5.0	6.3	7.6	9.9
Sixmile Creek	2.3	4.0	5.3	7.2	8.8
Oregon Creek	-	4.4	5.8	7.4	10.3
American Creek	-	3.9	5.3	6.9	9.3
California Creek	-	4.3	5.6	7.3	9.1
Willow Creek	-	4.0	5.4	6.8	8.0

The average lengths at age of Mount Haggin brook trout varied between streams and ranged from 3.4 inches in Sullivan Creek to 5.0 inches in Deep Creek at age I, 4.7 inches in Sullivan Creek to 6.3 inches in Deep Creek at age II, 5.8 inches in Sullivan Creek to 7.8 inches in Slaughterhouse Creek at age III and 8.0 inches in Willow Creek to 10.3 inches in Oregon Creek at age IV and older. Mean brook trout length at age for all Mount Haggin streams was 4.2 inches at age I, 5.6 inches at age II, 7.1 inches at age III and 9.0 inches at age IV and older.

Discussion

The most widely distributed gamefish in the streams of the Mount Haggin area is the brook trout. Brook trout are common to the upper Big Hole River and the majority of its tributaries (MDFWP, unpublished data). Brook trout were found in all of the Mount Haggin study sections and were virtually the only gamefish collected in Seymour, Sullivan and Twelvemile Creeks. Brook trout were introduced into the upper Big Hole River about 1929 (Liknes, 1981) and have become established in most tributary streams. The second most widely

distributed gamefish in the Mount Haggin streams is the rainbow trout. Deep and Tenmile Creeks received annual plants of hatchery rainbow trout between 1958 and 1966 and the Big Hole River is currently stocked on an annual basis near the mouths of Deep and Seymour Creeks (MDFWP Stocking Records). Records also show that rainbow trout were planted in Seymour and Willow Creeks during the 1940's and 1950's.

Cutthroat trout were collected from Sixmile and Willow Creeks. Cutthroat trout were probably native to all of the Mount Haggin streams. Numerous plants of hatchery cutthroat trout were made in Deep, Seymour and Willow creeks between 1928 and 1954 (MDFWP Stocking Records). These cutthroat are listed as being of undesignated strain meaning that their parental origin was from a mixture of cutthroat varieties. Specimens collected from Willow Creek were examined to determine if they were of the west slope cutthroat strain. The fish were found to be of the Yellowstone strain and have some west slope characteristics (Jim Roscoe, unpublished data). The present Willow Creek cutthroat trout population is probably a result of past plantings and may have replaced a native west slope population.

Small numbers of cutthroat trout in Sixmile Creek and low numbers of rainbow X cutthroat trout hybrids indicate that cutthroat trout still occupy the Deep Creek drainage. A previous electrofishing survey of the Mount Haggin streams found cutthroat trout in Tenmile Creek in a section located upstream from that surveyed in 1980 (MDFWP unpublished data).

Burbot and whitefish were generally found in the larger streams including Deep, French and California Creeks. Both species are native to the Big Hole River drainage and common throughout the major tributaries (Brown, 1971). Non-game species collected included longnose sucker, longnose dace and mottled sculpin. Sculpins were common to all of the streams and provide a valuable forage species for the trout and burbot. Like the burbot and whitefish, longnose dace and longnose suckers were most common in the larger streams studied.

Although no arctic grayling were captured during the study, this species has historically occupied Mount Haggin streams. Deep and Seymour Creeks enter the Big Hole River within the distributional limits of the present fluvial grayling population. Liknes (1981) reported collecting grayling in LaMarche Creek, a tributary stream entering the Big Hole River about three miles from the mouth of Seymour Creek. Arctic grayling have been collected from Deep Creek (Wipperman 1965 and 1967) and have been reported in fisherman catches as recently as the early 1970's (Lew Myers, personal communication). The origin of the Deep Creek grayling may have been native Big Hole River fish or progeny from a 1937 plant of nearly 752,000 grayling fry in the stream (MDFWP Stocking Records). The absence of grayling in the electrofishing survey may indicate that the species no longer occupies the Deep Creek drainage due to unfavorable conditions as discussed by Liknes (1981) or may be related to the selection of the study sections. It is possible that extensive electrofishing survey work could reveal grayling populations in other sections of streams in the Deep Creek or Seymour Creek drainages.

a) Populations

The electrofishing data indicated that the game fish populations of the Mount Haggin streams are heavily dominated by brook trout. Brook trout are the most abundant trout in the upper Big Hole River and the majority of its tributaries (MDFWP unpublished data). A look at past stocking records shows that despite numerous plantings of cutthroat and rainbow trout in Deep, Seymour, Tenmile and Willow Creeks, the brook trout has emerged as the strongest competitor in the habitat. This may be related to the brook trout's tolerance of low summer flows in small streams (Wipperman, 1966, 1967 and 1968), adaptability to streams that are heavily colonized by beaver or the harsh winter conditions of the area. In study sections for which it was possible to calculate estimates of rainbow or cutthroat trout in addition to brook trout, brook trout populations accounted for 81 to 95 percent of the estimated trout numbers and 82 to 93 percent of the estimated trout biomass.

Trout numbers generally ranged from good to excellent. Trout population averaged 329 per 1,000 feet in the Mount Haggin streams and exceeded 500 per 1,000 feet in Seymour, Sullivan and Willow Creeks. Trout numbers did not appear to be linked to stream size or the chemical enrichment of the water. Some of the chemically sterile streams (e.g. Sixmile and Oregon Creeks) supported 412 and 265 fish/1,000 feet while the two largest streams studied (Deep and California Creeks) supported 184 and 160 fish/1,000 feet.

Estimated trout populations were lowest in American and California Creeks. Furthermore, trout numbers in French Creek (30 fish/1,000 ft) and Deep Creek below the mouth of French Creek (34 fish/1,000 ft) were too low to calculate an estimate in a 1979 study (MDFWP unpublished data). The low numbers in American Creek were probably a function of the study section that was electrofished. Due to the presence of multiple channels and numerous beaver ponds, the study section had to be located in an area of steep gradient and swift currents. The population estimate for this section probably does not accurately reflect the carrying capacity of American Creek since large numbers of brook trout were observed in the small channels and beaver ponds immediately upstream. The low numbers of fish in California, French and Deep Creek below the mouth of French Creek are not as easily explained. Water quality data indicated potential problems with arsenic, lead, mercury, sediment and iron in sections of the California Creek-French Creek drainage. While none of these parameters exceeded EPA water quality standards in the grab samples, it is possible that one or a combination of these factors is acting to depress fish population throughout the system. The low fish populations may also be a result of habitat degradation from past grazing practices along these streams. California and French creeks exhibit many areas of eroded banks and a general deficiency of overhanging cover from streamside vegetation due to heavy concentration of cattle within the drainages. Bowers et al. (1979) considered stable streambank and adequate streamside vegetation as essential components of good trout habitat in streams.

b) Fish Size

The data from the study sections indicated that the Mount Haggin streams hold large populations of relatively small or "pan sized" trout.

The largest trout collected during the study were about eleven inches long and most of the catchable fish were within the 6 to 9 inch range. This size range is relatively typical for small streams in the upper Big Hole drainage (MDFWP unpublished data). For purposes of electrofishing efficiency, study sections were selected in reaches of streams that did not contain any beaver ponds. It is quite probable that larger fish occupy some of these beaver ponds and that the Mount Haggin streams have the potential to produce larger brook trout. Brook trout considerably larger than any collected during the sampling period have been reported in fisherman catches from Mount Haggin streams (Mike Frisina, personal communication).

Catchable brook trout (6 inches and longer) averaged 32 percent of the populations in the Mount Haggin streams. In Willow and Sullivan Creeks, where trout populations exceeded 700 and 600 fish per 1,000 feet, catchable fish composed 16 and 12 percent of the populations, respectively. There is some indication that these populations represent overcrowded conditions and some stunting. In Sixmile Creek, catchable fish represented only 9 percent of an estimated population of 412 per 1,000 feet. No indication of stunting was observed and Sixmile Creek appears to be an important rearing stream for young trout. Catchable fish comprised 63 and 55 percent of the population of Deep and California Creeks. Furthermore, most of the fish collected in French Creek in 1979 exceeded 6 inches in length and all of the fish collected in 1976 exceeded 7 inches in length. These data suggest that spawning or rearing conditions may not be favorable in California, French and Deep Creeks. The relatively large size of these streams may also be a factor, however, in reducing the efficiency of capturing smaller fish by electrofishing. The highest numbers of catchable fish (109-173/1,000 ft) in relatively large populations (314-519/1,000 ft) were collected in the Seymour, Twelvemile and Tenmile Creek study sections. These streams also contained the highest numbers of fish 7 inches and larger and held well balanced size distribution within the populations.

c) Condition and Weight

Brook trout condition was generally good in the Mount Haggin streams and averaged 41.01. This is considerably higher than the average condition of 37.50 found for brook trout in Prickley Pear Creek, Montana (Bishop, 1951). In a study of 18 other tributaries to the upper Big Hole River, brook trout condition averaged 41.02 (MDFWP unpublished data). For most of the Mount Haggin streams, condition increased markedly in the larger fish. Brook trout condition dropped below 40 in only four of the studied streams, Deep, French, American and Willow Creeks. These lower condition factors may be related to overcrowding in Willow Creek, steep gradient and swift current in the American Creek section and the previously discussed stresses in French Creek. Sullivan Creek, with its large, brook trout population, had a good average condition factor of 41.08.

Brook trout in Mount Haggin streams began to accumulate weight rapidly once they reached a length of about 6 inches. Approximate average weights for Mount Haggin brook trout were as follows: at 6 inches about .10 lb, at 7 inches about .15 lb, at 8 inches about .22 lb, and at 9 inches .31 lb. A weight of .5 lb was generally reached at a length between 10 and 11 inches.

d) Age Structure

For most Mount Haggin streams, over 75 percent of the estimated population was accounted for by age I and II fish. This is probably reflective of a normal population structure and corresponds with the findings of McFadden (1960) in studies of large brook trout population in Lawrence Creek, Wisconsin. Due to the difficulty of capturing very small fish, the only available estimate of age 0 fish was from Sixmile Creek where age 0 and age I fish accounted for 84 percent of the brook trout population. This data reinforces the importance of Sixmile Creek as a rearing stream for young trout. Relatively high percentages of the populations of California, Seymour and, to a lesser extent, Deep Creek were concentrated at Age III and older fish. In Seymour and Deep Creeks, populations of Age I and II fish were also relatively high but, in California Creek, only 13 percent of the population was estimated at age I. Again, the apparent low numbers of young fish may be due to unfavorable conditions in water quality or habitat.

The cutthroat trout population of Willow Creek was heavily shifted toward older fish. This may be a result of competitive factors from the large brook trout population. It is also possible that the study section was located in an area of marginal cutthroat habitat and that larger and more balanced populations exist in other portions of the stream. Likely areas for expanded cutthroat populations would probably be upstream of the study section nearer the headwaters of Willow Creek.

Brook trout length at age provided a rough index of growth and a basis for comparing Mount Haggin streams. Mean lengths of the different age classes of Mount Haggin brook trout indicated that growth is fairly slow. Comparable data from Prickley Pear Creek, Montana, shows that age II brook trout averaged almost two inches longer than those in Mount Haggin streams (Bishop, 1951) while age II brook trout in Blacktail Creek, Montana, averaged about three inches longer than those from Mount Haggin (Wipperman, 1966). The slower growth rates of the Mount Haggin brook trout may be due to harsh climatic conditions associated with higher elevations and the severe winters that typify the upper Big Hole basin or may be due to large concentrations of trout in waters of relatively low productivity or a combination of these factors.

Brook trout growth was generally fairly similar among the Mount Haggin streams. Growth appeared to most rapid in streams that exhibited a high degree of chemical enrichment e.g. Slaughterhouse and Sevenmile Creeks. Growth was slowest in streams that supported extremely high brook trout populations e.g. Sullivan and Willow Creeks. This effect became more pronounced as the fish increased in age.

e) Recreational Fishing

The Mount Haggin streams offer an excellent fishery for "pan sized" brook trout and limited opportunities to catch rainbow trout, cutthroat

trout, burbot and whitefish. Present brook trout populations appear capable of sustaining a fairly intensive fisherman harvest. Populations in Sullivan and Willow Creeks would probably benefit from such harvest. Fisherman use of Mount Haggin streams has been documented to a very limited degree. Fishing pressure was estimated by mail survey for 1975-76 at 357 fisherman days on California Creek, 269 fisherman days on French Creek, 560 fisherman days on Willow Creek and 1,005 fisherman days on Mill Creek (MDFWP 1976). Week day observation during the summer of 1980 indicated that fisherman use of the streams was light. Preliminary observations indicate that the Mount Haggin streams represent a harvestable recreational fishery that is lightly exploited at present. An inventory of fisherman use and harvest on Mount Haggin streams would provide valuable information for future management of the fisheries.

INSTREAM FLOW RECOMMENDATIONS

Introduction

Instream flow has recently come to be recognized as a major determinant in the capability of a stream or river to support populations of fish and provide riparian and aquatic habitat for game, nongame and furbearing animals. Because the aquatic habitat of a stream is directly dependent on the amount of water within its channel, a particular habitat level will be linked to a particular flow regime. In this manner, discharge regimes capable of maintaining optimum, high, low and critical levels of aquatic habitat potential can be identified when supported by appropriate hydrological and biological data (MDFWP, 1976).

The MDFWP has undertaken a program to determine the instream flow requirements of numerous streams throughout the state and to make instream flow recommendations for fish and wildlife habitat preservation on these streams. Thirteen streams lying within the boundaries of the Mount Haggin Wildlife Management Area were selected for instream flow recommendations in 1979 and 1980.

The Mount Haggin Wildlife Management Area was obtained from the Nature Conservancy by the MDFWP in 1976. The 55,000 acre area contains a rich aquatic resource with part or all of 28 named streams and numerous unnamed streams found within its boundaries. Mount Haggin area streams originate on both the eastern and western slopes of the Continental Divide and contribute tributary flow to the Big Hole River of the Missouri Basin and the Clark Fork River of the Columbia Basin.

Recreational Use

The Mount Haggin area is an important recreational resource. The many streams support an abundant brook trout fishery and lesser numbers of cutthroat trout, rainbow trout, mountain whitefish, and burbot. Arctic grayling have been collected in Deep Creek in the past (Wipperman, 1967). Fisherman use of the area has been documented for a small number of streams (MDFWP, 1976), however, observations made during the summer of 1980 indicate a lightly used resource.

Lands within the area support substantial populations of elk, moose, mule deer and black bear and are heavily used for big game hunting (Frisina, 1980). Hunting district 319, which includes the Mount Haggin area, provided an estimated 34,216 hunter days for elk and mule deer in 1980 (MDFWP, 1980) and, on a per acre basis, supports the highest elk hunter numbers of any district in Montana (Frisina, personal communication). Important moose and deer winter ranges and elk migration routes are found on the Mount Haggin property. Willow bottoms, particularly those in the Deep, Seymour and Willow Creek drainages, provide important moose winter range. Many predators and furbearers are found in the Mount Haggin drainages. Beaver provide a fur harvest on most of the larger streams. During the 1980-81 trapping season, the Mount Haggin area was utilized by five furbearer trappers and four predator trappers on a permit basis.

In addition to hunting, fishing and trapping, the Mount Haggin property is used for winter recreation in the form of cross-country skiing and particularly snowmobiling. MDFWP has provided a parking area and access that is heavily used by snowmobilers.

Past Commercial Use

The Mount Haggin area has played an important historical role in the commercial development of the Anaconda area. Placer gold mining was succeeded by logging and finally livestock grazing in the economic development of the Mount Haggin drainages (Newell, 1980). Gold deposits discovered in French Creek in 1864, yielded between $1 and $5 million in the first four years they were worked (Lyden, 1948). By 1877, gold mining by rocker and sluice box were replaced by hydraulic mining operations, dredges and underground load mines. Gold placer operations were also located on Oregon, California and Beefstraight Creeks on the Mount Haggin area.

Commercial timber harvest began in the area in the Mill Creek canyon along the Continental Divide in 1883. The area was clear cut and has not reforested to date. Between 1906 and 1915 approximately 79 million board feet of timber were harvested from the French Gulch vicinity to provide cordwood and mine stulls to the Anaconda Company (Newell 1980). At the completion of the French Gulch timber harvest in 1917, livestock grazing became the principal commercial practice on the Mount Haggin area and persisted through the purchase of the land by the MDFWP.

Commercial utilization of the Mount Haggin streams followed the commercial development of the area. Hydraulic gold mining of placers required the concentration of large amounts of water on gravel beds or benches. One such hydraulic operation in French Gulch used water diverted from American, California and Oregon Creeks. Mount Haggin water was also diverted to transport timber from French Gulch to a site near Anaconda. Water was diverted from American, California, Mill and other streams to a massive flume that was used to float the timber (Newell, 1980). Finally, water from many of the Mount Haggin streams was diverted to irrigate crops or grasslands as ranching became the primary commercial use of the area.

Present Commercial Use

Present commercial activities taking place on the Mount Haggin area include livestock grazing and timber harvest. At the time of the land acquisition by the MDFWP, a five year grazing contract with the Mount Haggin Livestock Company was in effect. The contract was renegotiated in 1981 and calls for a three pasture rest-rotation grazing system for 4,000 animal unit months through a four month grazing season. The three pastures represent a limited segment of the Mount Haggin area.

A timber harvest contract with the Louisiana Pacific Corporation was also in effect at the time of the Mount Haggin purchase. The contract calls for the harvest of merchantable timber, roundwood and pulpwood and will be in effect for approximately seven more years. The Mount Haggin interim management plan calls for the implementation of each contract with the minimum impact to the resource allowable under the terms of the contract.

Methods

The procedure utilized by the MDFWP to quantify instream flow recommendations is the wetted perimeter method. Wetted perimeter is the distance along the bottom and sides of a stream channel cross section that is in contact with water. Wetted perimeter is a direct function of discharge but the rate at which it increases or decreases is not constant throughout the discharge range and is modified by channel configuration. Wetted perimeter increases rapidly with small increases in flow up to the point where the stream nears its maximum width. The rate of increase then slows as the water moves up the stream banks with increasing discharge. In small streams, there are usually two points, termed the lower and upper inflection points, which can be depicted on a plot of wetted perimeter versus discharge and which represent significant changes in the rate of increase or decrease of wetted perimeter with flow.

Studies have shown that the wetted perimeter-discharge relationships for selected channel cross sections can be used to quantify instream flow needs for the maintenance of trout habitat (Nelson, 1980). As the wetted perimeter decreases and pulls away from stream banks, accompanying losses of riffle habitat for the production of benthic food organisms, spawning sites, inshore rearing areas and streambank cover can occur. In this manner, wetted perimeter can be related to various levels of aquatic habitat potential.

The methods used to derive wetted perimeter-discharge relationships on Mount Haggin streams are given in Nelson (1980b). A study section or subreach was established on each stream that was examined at Mount Haggin. Each subreach was selected to typify the stream habitat and generally contained riffle and run habitat. Pool habitat occurred in few of the subreaches due to high gradients of these headwater streams. Five cross sections were selected for study within each subreach.

Data collection usually consisted of three sets of stage (water surface elevation) measurements for each cross section at three different known discharges. The stage-discharge data were collected at high (as runoff is receding), intermediate (near the end of runoff) and low (late summer) flows. A fourth stage-discharge measurement was collected at a second intermediate flow on some of the streams. The final set of data collected in the field consisted of a measurement of the stream channel profile through each cross section. The profile measurements were made during the low flow period.

The stage-discharge data and cross sectional profile measurements were entered into the wetted perimeter predicative computer program (WETP) (Nelson, 1980b) for analysis. The WETP program uses stage-discharge data to derive a stage-discharge rating curve for each cross section by least squares fit. The rating curve, when coupled with the cross-sectional profile, was used to predict wetted perimeter at selected flows of interest for each stream.

Because riffles are the areas of a stream most affected by flow reduction (Bovee, 1977 and Nelson 1980a) and because the riffle habitats are essential for the maintenance of good trout populations, composites of the riffle cross section for each Mount Haggin stream were analyzed for an instream flow recommendation. Plots of wetted perimeter versus discharge for composites of riffle cross sections were analyzed to determine lower and upper inflection points. These inflection points provide a range of flows which are believed to brackett those flows which are necessary to maintain the high and low levels of aquatic habitat potential (Nelson, 1980a). The final instream flow recommendation is selected from this range of flows. The selection was based on the magnitude and composition of existing fish populations, water availability and quality, the recreational use or potential use, the existing level of environmental degradation and flow contribution to downstream water quality. Fish populations were determined by electrofishing 1,000 foot sections of each stream. Instream flow recommendations were determined for American, California, Oregon, Sevenmile, Seymour, Sixmile, Slaughterhouse, Sullivan, Tenmile, Twelvemile and Willow Creeks during the course of this study. Two other Mount Haggin streams, Deep and French Creeks, were analyzed in 1979 under a separate project by Janet Decker-Hess of the MDFWP (MDFWP, 1981).

1. STREAM

American Creek

2. DESCRIPTION

American Creek originates on the eastern slope of the Anaconda-Pintlar Range at the Continental Divide. It flows in a westerly direction for approximately 5.7 miles to its confluence with California Creek, a tributary of French Creek. American Creek meanders through a relatively narrow floodplain vegetated with willow, alder, grasses and sedges and characterized by numerous beaver ponds. The 7.1 square mile drainage area is characterized by high south facing meadows and heavily timbered slopes. The only major tributary of American Creek is Little American Creek. Average gradient of the 11 foot wide channel is 46.6 feet per 1,000 ft. Ownership of the American Creek drainage is held by the Montana Department of Fish, Wildlife and Parks.

Lands within the American Creek drainage are used for recreation in the form of hunting, fishing, trapping and snowmobiling. Past commercial uses include livestock grazing, timber harvest and diversion of water to Moose Creek for the Anaconda timber flume. Grazing of cattle and timber harvest continue in the drainage at present. No estimate of fishing pressure is available for American Creek; however, some fishermen were observed during the summer of 1980.

Water chemistry samples were collected from American Creek during the summer of 1980. The chemical data generally indicate good water quality with very little suspended sediment. American Creek is a calcium-magnesium-bicarbonate water exhibiting slightly higher than average specific conductance, alkalinity and hardness than most streams in the upper Big Hole drainage. Slightly elevated arsenic levels indicated some disturbance probably due to precipitates from the Anaconda Smelter.

American Creek is bordered by a relatively broad riparian zone and stable banks. Potential environmental problems include sedimentation from existing and proposed areas of timber harvest and damage to the stream banks and riparian zone from cattle.

3. FISH POPULATIONS

A 1,000 foot section of American Creek was electrofished on August 7 and August 19, 1980. Game fish present in descending order of abundance were brook trout, rainbow trout and rainbow X cutthroat hybrids. Mottled sculpins were the only nongame species captured (Table 10).

Table 10. Summary of electrofishing survey data for a 1,000 ft section of American Creek (T3N, R11W, Sec. 30C) on August 7 and August 19, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	147	2.0 - 10.2
Rainbow Trout	8	6.4 - 9.2
Rainbow X Cutthroat Hybrids	1	9.5
Mottled Sculpin	-	-

Standing crops of brook trout and rainbow trout in the study section were estimated using a mark-recapture method (Table 11). The section supported approximately 160 brook trout and 8 rainbow trout representing a combined biomass of 13 lbs. Catchable fish (6 inches and larger) composed 24 percent of the brook trout population. Brook trout condition (length to weight ratio) was good although slightly below average when compared with other Mount Haggin streams and other streams in the upper Big Hole River drainage (MDFWP unpublished data).

Table 11. Estimated standing crops of brook and rainbow trout in a 1,000 foot section of American Creek (T3N, R11W, Sec. 30C) on August 7, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Per 1,000 ft. Pounds
Brook Trout	3.2 - 5.9	122	
	6.0 - 10.2	38	
		160(±24)	12(±1)
Rainbow Trout	6.0 - 9.2	8	
		8(±3)	1(±0)

A brief reconnaisance of American Creek was conducted by MDFWP fisheries biologists in 1976. They rated the stream as having a good fishery potential for the production of catchable brook trout.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected for a 169 foot riffle-run sequence located approximately at stream mile .2 (T3N, R12W, Sec 25D). Five cross

sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 31.8, 16.6, 11.2, and 6.7 cfs.

The relationship between wetted perimeter and dishcarge for a composite of four riffle cross sections is shown in Figure 3. Lower and upper inflection points occur at 4 and 8 cfs. Based on an evaluation of the existing fishery, recreational potential and headwater contribution to water quantity and quality in the Big Hole River, a flow of 6 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for American Creek.

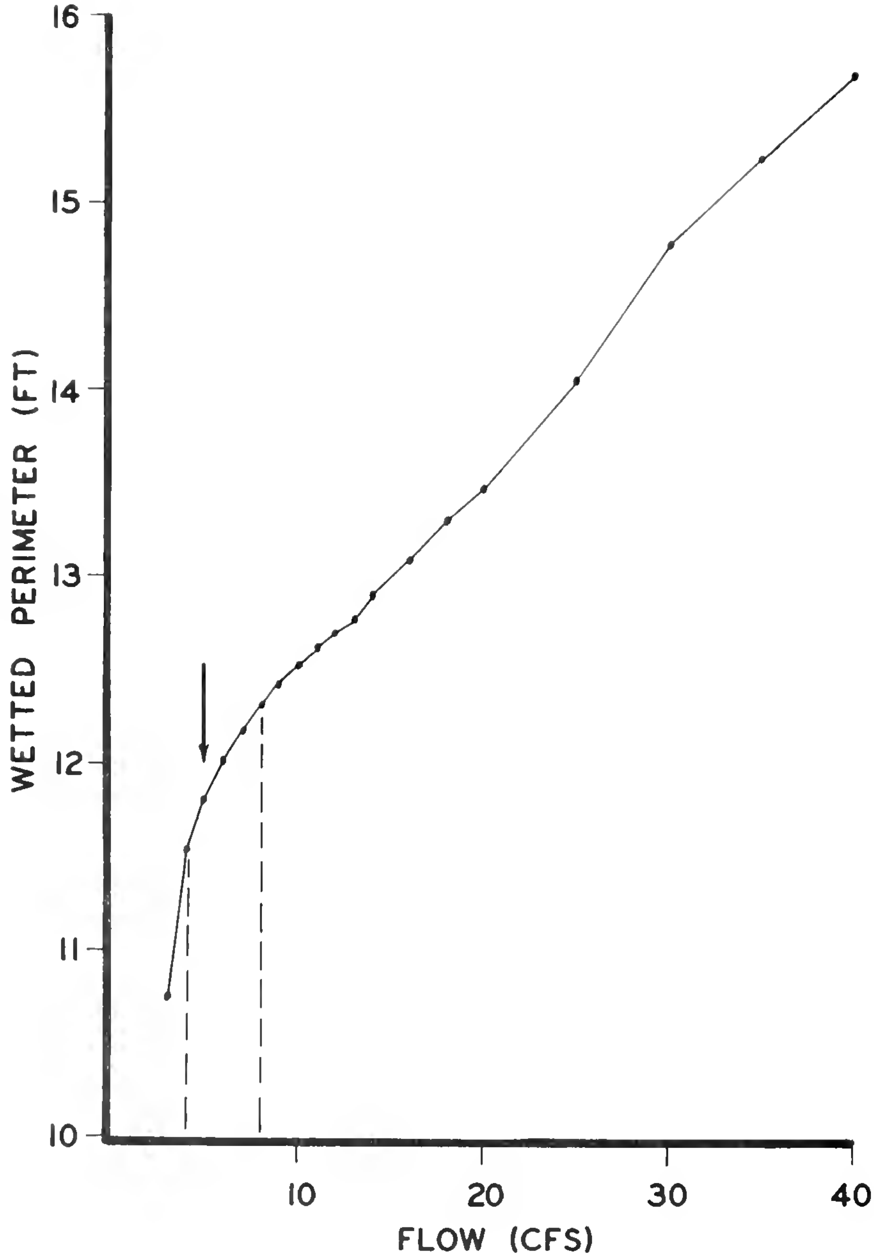


Figure 3. The relationship between wetted perimeter and flow for a composite of four riffle cross sections in American Creek.

1. STREAM

California Creek

2. DESCRIPTION

California Creek originates on the eastern slope of the Anaconda-Pintlar Range at the Continental Divide. It flows in a southerly direction for approximately 7.7 miles to its junction with French Creek. California Creek meanders through a narrow floodplain characterized by a relatively narrow riparian zone. For most of its length, the stream is bordered by grass and sedge meadows containing scattered clumps of willow and alder. The 28.4 square mile drainage area is characterized by high south facing slopes bearing little coniferous growth in the headwater region and timbered foothills and grass-sedge meadows downstream. Major tributaries of California Creek include Crooked John, Little California, Oregon, Sixmile and American Creeks. The average gradient of the 22 foot wide channel is 29.5 feet per 1,000 ft. The majority of the California Creek drainage is owned by the MDFWP while a very small portion lies on USFS land.

Lands within the California Creek drainage are used for recreational hunting, fishing and snowmobiling. The lower portions of the drainage are used for trapping. Past commercial uses of the drainage include placer mining (Lyden 1948), timber harvest and livestock grazing (Newell 1980), and diversion of water for irrigation and timber transport. Intensive grazing and timber harvest continue in the drainage at present. Fishing pressure on California Creek in 1975-76 was estimated at 357 fisherman-days per year (MDFWP, 1976). This translates to 46 fisherman days per stream mile/year.

Chemical analyses were performed on water samples collected during the summer of 1980. The data revealed that California Creek is a calcium-magnesium-bicarbonate water of slightly basic pH. The stream has a higher specific conductance, alkalinity and hardness than most waters in the upper Big Hole River drainage. Relatively high arsenic, total recoverable iron and suspended sediment levels were measured in California Creek. The source of the arsenic is probably precipitates from the Anaconda Smelter. High levels of suspended sediment (235.8 mg/l) and total recoverable iron (6.5 mg/l) were measured following a brief summer rain. The source of the sediment and iron is believed to be erodable soils in the vicinity of Sugarloaf Mountain. This area was clear-cut in the late 1800's and has revegetated very slowly due to precipitates from the Anaconda Smelter, sheep grazing and fires. The California Creek stream banks and riparian areas exhibit evidence of erosion and trampling from concentrations of cattle. Other environmental concerns include sediment loading and elevated concentrations of arsenic and total recoverable iron.

3. FISH POPULATIONS

A 1,000 foot section of California Creek was electrofished on August 4 and August 18, 1980. Game fish present in descending order of abundance were brook trout, rainbow trout, mountain whitefish and burbot. Nongame species captured were mottled sculpin, longnose sucker and longnose dace. Electrofishing survey data are presented in Table 12.

Table 12. Summary of electrofishing survey for a 1,000 foot section of California Creek (T2N, R12W, Sec 1B) on August 4 and August 18, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	97	3.6 - 10.2
Rainbow Trout	23	2.4 - 8.9
Mountain Whitefish	9	6.8 - 12.6
Burbot	1	11.0
Mottled Sculpin	-	-
Longnose Sucker	-	-
Longnose Dace	-	-

Standing crops of brook trout and rainbow trout in the study section were estimated using a mark-recapture method (Table 13). The section supported approximately 130 brook trout and 30 rainbow trout representing a combined biomass of 19 pounds. Catchable fish (6 inches and longer) composed 55 percent of the brook trout and 47 percent of the rainbow trout populations. Brook trout condition (length to weight ratio) was above average for Mount Haggin streams and other streams in the Big Hole River drainage (MDFWP unpublished data). A 325 foot section of California Creek was electrofished in 1976 (MDFWP unpublished data). Game fish captured during this survey included 19 brook trout (length 4.8 - 9.1 inches) and one burbot. As a result of the inventory, the fishery potential of California Creek was rated as good.

Table 13. Estimated standing crops of brook and rainbow trout in a 1,000 foot section of California Creek (T2N, R12W, Sec 1B) on August 4, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft Number	Per 1,000 ft Pounds
Brook Trout	3.6 - 6.9	86	
	7.0 - 10.2	44	
		130(±20)	16(±2)
Rainbow Trout	3.9 - 8.9	30	
		30(±10)	3(±1)

The brook trout population of California Creek was low (40 percent of average) when compared with other Mount Haggin streams. The relatively large size of California Creek and the frequency of relatively deep pool habitat gave the appearance of a stream capable of supporting larger populations of game fish. Low numbers of trout in the study section may be related to sediment loading, high arsenic or iron levels or bank instability due to intensive livestock use. While present game fish populations in the section are low, it is probable that California Creek has the potential to support much larger numbers of fish.

4. FLOW RECOMMENDATIONS

Cross-sectional data were collected in a 252 foot riffle-run sequence located approximately at stream mile .15 (T2N, R12W, Sec 1B). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at discharges of 94.6, 43.1 and 14.0 cfs.

The relationship between wetted perimeter and discharge for a composite of three riffle cross sections is shown in Figure 4. Lower and upper inflection points occur at 10 and 14 cfs. Based on an evaluation of the existing fishery, recreational use, and contributing flow to the Big Hole River, a flow of 12 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for California Creek.

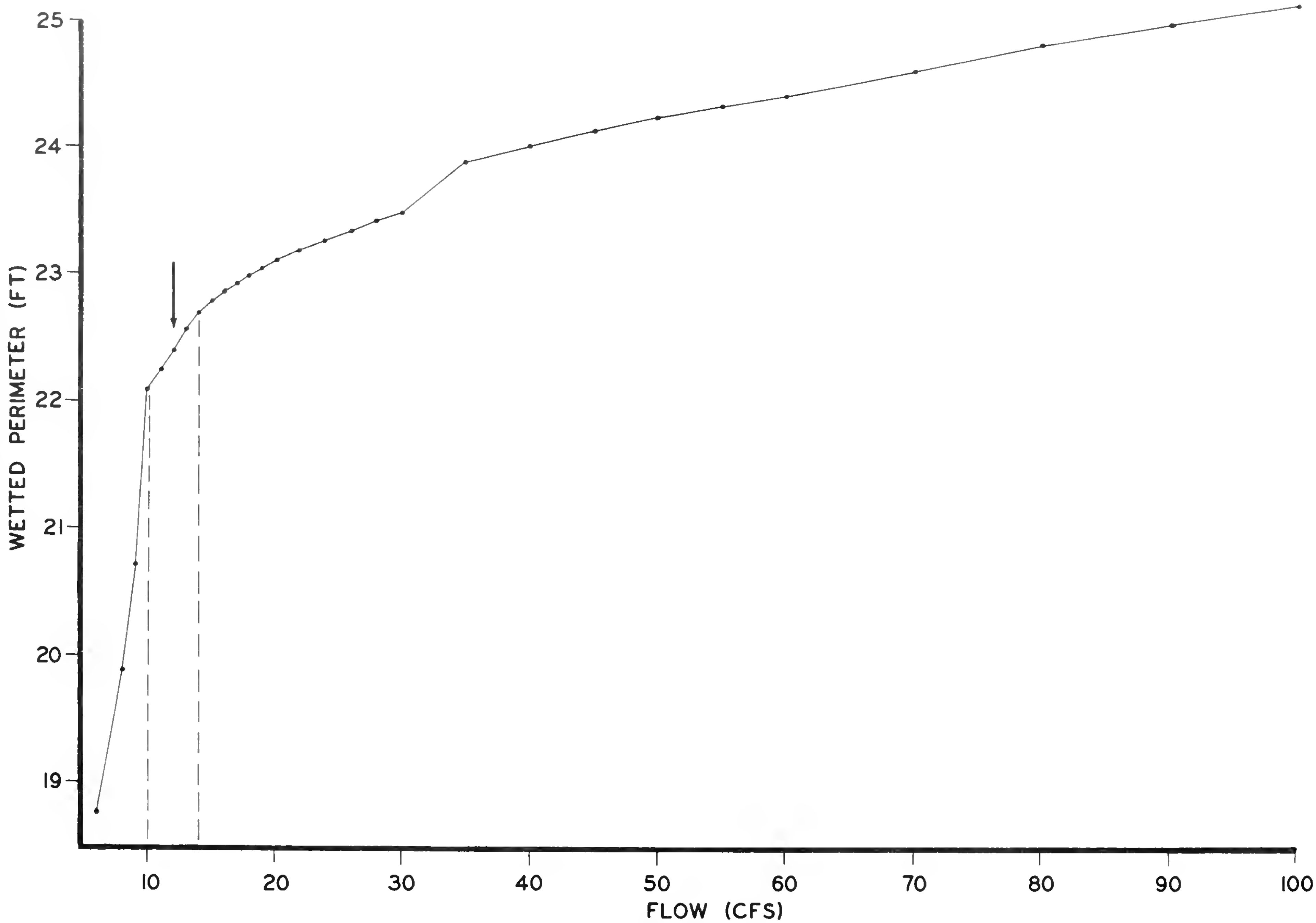


Figure 4. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in California Creek.

1. STREAM

Oregon Creek

2. DESCRIPTION

Oregon Creek originates on the east slope of the Anaconda-Pintlar Range at the Continental Divide and flows in a southerly direction for about 1.2 miles to its mouth on California Creek. It meanders through a very small floodplain and is bordered by a narrow riparian zone. Streamside vegetation is composed primarily of grasses and sedges with small clumps of willow and alder scattered intermittantly. Coniferous growth is extremely sparse throughout the 1.8 square mile drainage and streamside canopy is restricted to willow clumps or is lacking. The lower reaches of the stream are bordered by till from a placer mining operation. The drainage is characterized by high open south-facing slopes. Oregon Creek has no major tributaries. The average gradient of the 7.5 foot wide channel is 31.6 feet per 1,000 ft. Ownership of the Oregon Creek drainage is held entirely by the MDFWP.

Recreational uses of the Oregon Creek drainage include hunting, fishing and snowmobiling. No estimate of fishing pressure is available for Oregon Creek and no fisherman use was observed during the summer of 1980. The drainage has been used in the past for commercial livestock grazing, timber harvest (Newell 1980), and placer gold mining (Lyden 1948). Present commercial use of the drainage is confined to cattle grazing.

Water chemistry samples were collected from Oregon Creek during the summer of 1980. Chemical data indicated that Oregon Creek is a calcium-sodium-bicarbonate water of moderate specific conductance, alkalinity and hardness. Water quality was generally good except for the presence of elevated levels of arsenic (average 24.9 ug/l) and lead (.08 mg/l). The probable source of the arsenic is the Anaconda Smelter. Other existing environmental problems include sedimentation from the slumping roadbed of Highway 274 and channel and streambank alteration from past placer mining activities.

3. FISH POPULATIONS

A 1,000 foot section of Oregon Creek was electrofished on August 5 and August 14, 1980. Game fish captured in descending order of abundance were brook trout and rainbow trout. Mottled sculpins were the only nongame species present. Electrofishing survey data is given in Table 14.

Table 14. Summary of electrofishing survey for a 1,000 foot section of Oregon Creek (T3N, R11W, Sec. 20C) on August 5 and August 14, 1981.

Species	No. Captured	Length Range (inches)
Brook Trout	275	2.5 - 11.1
Rainbow Trout	4	4.6 - 8.3
Mottled Sculpin	-	-

The standing crop of brook trout in the study section was estimated by using a mark-recapture method (Table 15). The section supported approximately 265 brook trout representing a biomass of 24 pounds. Catchable fish (6 inches and larger) composed 38 percent of the brook trout populations. Brook trout condition (length to weight ratio) was excellent and above average for Mount Haggin streams and upper Big Hole River tributaries (MDFWP unpublished data).

Table 15. Estimated standing crop of brook trout in a 1,000 foot section of Oregon Creek (T3N, R11W, Sec 20C) on August 5, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Pounds
Brook Trout	3.5 - 6.9	221	
	7.0 - 11.1	44	
		265(±28)	24(±3)

The trout populations observed in the study section revealed a good fishery relative to the size of Oregon Creek. Fisheries in the lower reaches of the stream may be affected by habitat destruction from past placer mining operations and sediment loading from a slumping hillside and subsequent slumping of the roadbed of Highway 274 at the Oregon Creek road crossing.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected in a 178 foot riffle-pool-run sequence located approximately at stream mile .2 (T3N, R11W, Sec 30B). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 8.9, 4.7 and 0.5 cfs.

The relationship between wetted perimeter and discharge for a composite of two riffle cross sections is shown in Figure 5. Lower and upper inflection points occur at .4 and 2 cfs. Based on an evaluation of the existing fishery, a flow of 1 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June)cannot be derived for Oregon Creek.

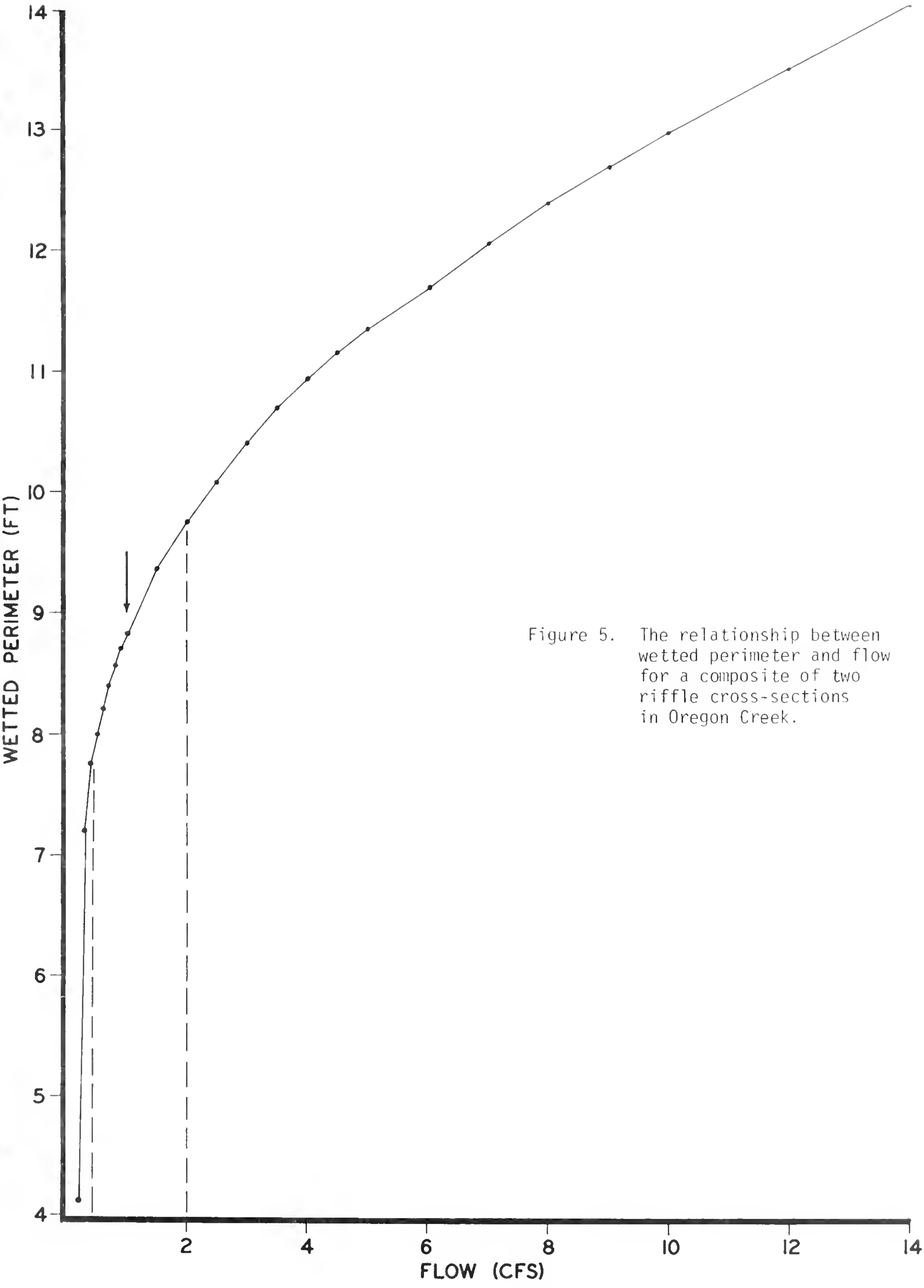


Figure 5. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in Oregon Creek.

1. STREAM

Sevenmile Creek

2. DESCRIPTION

Sevenmile Creek originates on the east slope of the Anaconda-Pintlar Range at the Continental Divde and flows in a southerly direction for about 5.6 miles to its juncture with Tenmile Creek to form Deep Creek. The stream drops rapidly through a narrow, steep -sided canyon in the upper reaches and meanders through grasslands and willow bottoms in the lower reaches. The 5 square mile drainage area is characterized by open south facing slopes and timbered conferous ridges. Streamside vegetation is typically riparian in nature and composed primarily of willow, alder, grasses and sedges. Numberous beaver ponds are found in the lower reaches of the stream. Sevenmile Creek has no major tributaries. The average gradient of the 6.1 foot wide channel is 37.2 feet per mile. Ownership of the Sevenmile Creek drainage is controlled mainly by the MDFWP while a small portion of the drainage is under USFS control.

Lands within the Sevenmile Creek drainage are used for recreational purposes; primarily hunting, fishing and snowmobiling. No estimate of fishing pressure is available for Sevenmile Creek; however, some fishermen were observed during the summer of 1980. Past commercial uses of the drainage include livestock grazing, timber harvest and numerous diversion of water for agriculture, mining and timber harvest. Present commercial uses include livestock grazing and possible timber harvest.

Chemical analyses were performed on water samples collected during the summer of 1980. The data revealed that Sevenmile Creek is a calcium-magnesium-bicarbonate water of slightly basic pH. Specific conductance, total alkalinity, hardness and nitrate concentrations were much higher than values measured from other Mount Haggin streams, resulting in a chemically rich water of good quality. Environmental concerns include streambank instability and erosion in the lower reaches of the stream resulting from vehicular travel and livestock use.

3. FISH POPULATIONS

A 1,000 foot section of Sevenmile Creek was electrofished on August 12 and August 21, 1980. Game fish captured in descending order of abundance were brook trout, rainbow trout and rainbow-cutthroat hybrid trout. Nongame species present were mottled sculpin and longnose suckers. Electrofishing survey data are presented in Table 16.

Table 16. Summary of electrofishing survey for a 1,000 foot section of Sevenmile Creek (T3N, R12W, Sec. 34A) on August 12 and August 21, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	149	2.1 - 10.1
Rainbow Trout	2	4.8 - 7.7
Rainbow X Cutthroat	1	7.7
Mottled Sculpin	-	-
Longnose Sucker	-	-

The standing crop of brook trout in the study section was estimated by using a mark-recapture method (Table 17). The section supported approximately 183 brook trout representing a biomass of 13 pounds. Catchable fish (6 inches and larger) composed 30 percent of the populations. Brook trout condition (length to weight ratio) was slightly below average for Mount Haggin streams and other streams in the upper Big Hole River drainage (MDFWP unpublished data).

Table 17. Estimated standing crop of brook trout in a 1,000 foot section of Sevenmile Creek (T3N, R12W, Sec. 34A) on August 12, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Pounds
Brook Trout	3.0 - 4.9	83	
	5.0 - 6.4	68	
	6.5 - 10.1	31	
		183($\pm$29)	13($\pm$2)

A 300 foot section of Sevenmile Creek (T3N, R12W, Sec 26) was electrofished in 1976 (MDFWP unpublished data). Forty-one brook trout ranging in size from 3.3 - 11.5 inches were captured. The fishery potential of Sevenmile Creek was rated as good at the time of the inventory.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected in a 190 foot run sequence located approximately at stream mile .1 (T3N, R12W, Sec. 34BC). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 12.7, 5.7 and 1.8 cfs.

The relationship between wetted perimeter and discharge for a composite of three run cross sections is shown in Figure 6. Lower and upper inflection points occur at 2 and 3.5 cfs. Based on an evaluation of the existing fishery and recreational use potential,a flow of 2.5 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Sevenmile Creek.

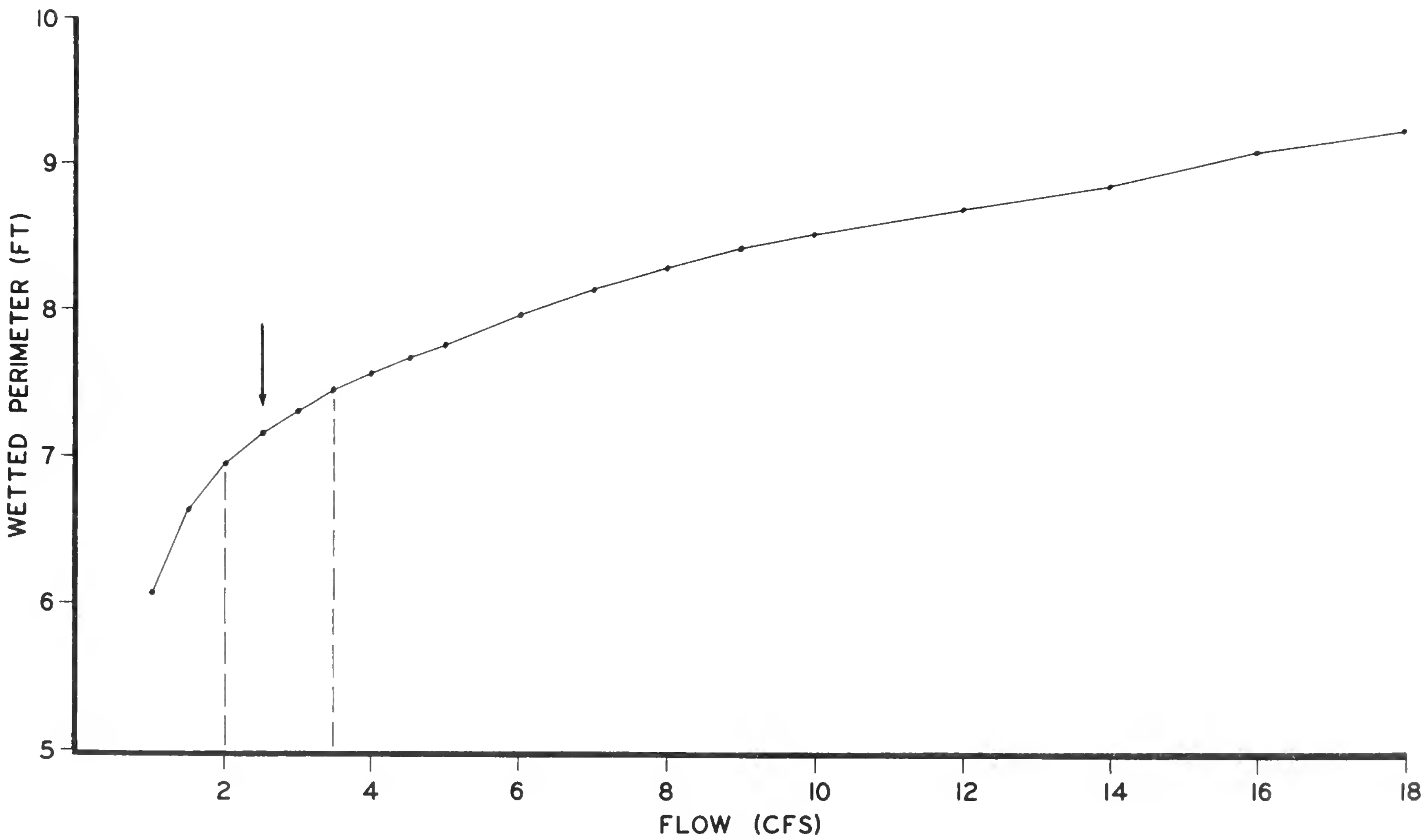


Figure 6. The relationship between wetted perimeter and flow for a composite of three run cross-sections in Sevenmile Creek.

1. STREAM

Seymour Creek

2. DESCRIPTION

Seymour Creek originates on the east slope of the Anaconda-Pintlar Range at the Continental Divide. The extreme upper reaches of the stream lie within the Anaconda-Pintlar Wilderness area. The stream flows in a southerly direction for approximately 16.8 miles to its confluence with the Big Hole River. The majority of the 31.7 square mile drainage lies within the Beaverhead and Deer Lodge National Forests while smaller portions of the lower drainage are under the control of the MDFWP and private landowners. The upper drainage is characterized by alpine meadows and steep heavily timbered canyons and ridges. The stream meanders through broad willow bottoms and grass and sedge meadows in the lower drainage. Upper and lower Seymour Lakes as well as numerous unnamed lakes lie within the drainage. Riparian vegetation is primarily composed of willow, alder, grasses and sedges. Numerous beaver ponds characterize the lower drainage. The only major tributary of Seymour Creek is Chub Creek. The average gradient of the 22 foot wide channel is 36.7 feet per 1,000 feet.

Lands within the Seymour Creek drainage are used for recreation in the form of hunting, fishing, trapping, camping, backpacking and winter sports. The lower drainage is considered to be high quality winter range for moose (Frisina, personal communication). No estimate of fishing pressure is available for Seymour Creek; however, numerous fishermen were observed during the summer of 1980. Fishing pressure on Seymour Lake in 1975-76 was estimated at 469 fishermen days (MDFWP, 1976). Past and present commercial uses of the drainage include livestock grazing, timber harvest and diversion of water for irrigation.

Chemical analyses were performed on water samples collected from Seymour Creek during the summer of 1980. The data revealed that Seymour Creek has excellent water quality marked by very low specific conductance, alkalinity, hardness, suspended sediment and concentrations of dissolved ions. The stream is a weak calcium-magnesium-bicarbonate water of nearly neutral pH. Seymour Creek streambanks and riparian areas are relatively stable and in good condition. Potential environmental impacts are sedimentation from existing clear cut areas and roads and damage to riparian areas and banks from cattle.

3. FISHERIES

A 1,000 foot section of Seymour Creek was electrofished on August 11 and August 25, 1980. The only game fish captured were brook trout while the mottled sculpin was the only nongame species collected. Electrofishing data are summarized in Table 18.

Table 18. Summary of electrofishing survey for a 1,000 foot section of Seymour Creek (T2N, R13W, Sec 13D) on August 11 and August 25, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	273	2.2 - 10.2
Mottled Sculpin	-	-

The standing crop of brook trout in the study sections was estimated using a mark-recapture method (Table 19). The section supported approximately 519 brook trout exhibiting a biomass of 41 pounds. Catchable fish (6 inches and longer totaled 173, as compared with an average of 88 per thousand feet for all Mount Haggin streams, and composed 33 percent of the populations. Mean condition (length to weight ratio) of Seymour Creek brook trout was slightly below the average for Mount Haggin streams and other tributaries of the upper Big Hole River.

The data from the study section indicate that Seymour Creek supports a very good population of brook trout.

Table 19. Estimated standing crop of brook trout in a 1,000 foot section of Seymour Creek (T2N, R13W, Sec 13D) on August 11, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Per 1,000 ft. Pounds
Brook Trout	3.2 - 4.9	263	
	5.0 - 6.9	177	
	7.0 - 10.2	79	
		519 (±111)	41(±5)

Low numbers of arctic grayling have been collected in Deep Creek (Wipperman, 1965 and Wipperman, 1967a) and LaMarche Creek (Liknes, 1981), the two tributaries to the Big Hole River immediately downstream and upstream from Seymour Creek. The arctic grayling is classified as a species of special concern (Deacons et al. 1979) and the only substantial fluvial population of the species in Montana is restricted to the upper Big Hole River and its tributaries (Liknes, 1981). It is possible that small numbers of arctic grayling currently inhabit portions of Seymour Creek although none were captured in the study section.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected in a 321 foot riffle-run sequence located approximately at stream mile 3.6 (T2N, R13W, Sec 13D). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at discharges of 87.6, 55.0 and 10.1 cfs.

The relationship between wetted perimeter and discharge for a composite of three riffle cross sections is shown in Figure 7. Lower and upper inflection points occur at 10 and 13 cfs. Based on an evaluation of the existing fishery, recreational use potential and flow contribution to the Big Hole River, a flow of 12 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long-term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Seymour Creek.

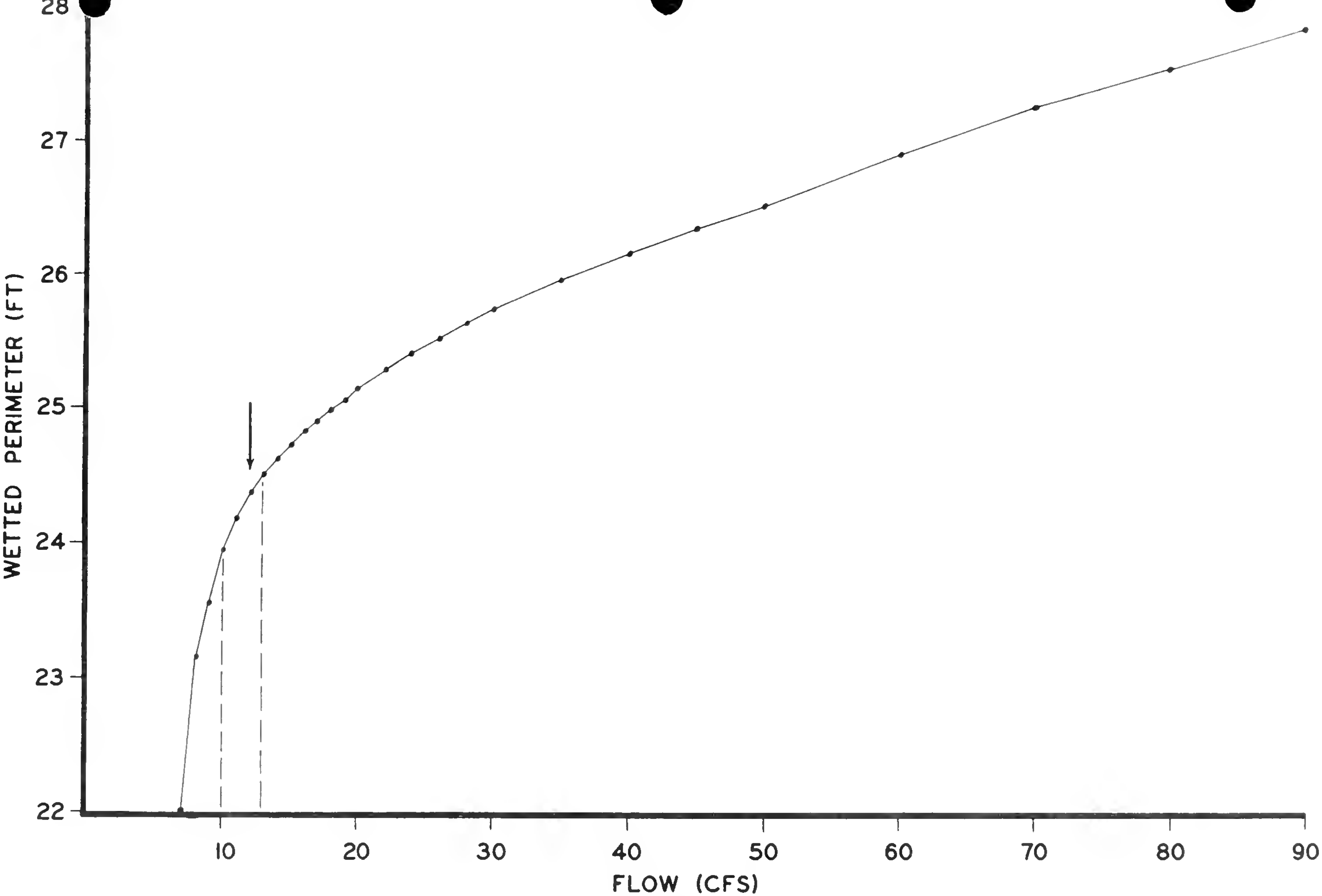


Figure 7. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in Seymour Creek.

1. STREAM

Sixmile Creek

2. DESCRIPTION

Sixmile Creek originates on the east slope of the Anaconda-Pintlar range at the Continental Divide. The stream flows in a southerly direction for approximately 3.0 miles to its confluence with California Creek and has no major tributaries. The 4.2 square mile drainage is characterized by high open south facing slopes bearing little coniferous growth. The stream drops rapidly through a narrow floodplain and is bordered by a narrow riparian zone containing willow, alder, aspen, grasses and sedges. The average gradient of the 6.3 foot wide channel is 44.1 feet per thousand feet. Ownership of the drainage is controlled by the MDFWP.

Lands within the drainage are utilized for recreational hunting, fishing, and snowmobiling. No estimate of fishing pressure is available for Sixmile Creek; however, some fishermen use was observed. Past commercial uses of the drainage include timber harvest, livestock grazing and diversion of water to the McCune flume for timber transport and to the Home Ranch for irrigation. Sixmile Creek flows through the Mule Ranch, an important historical site in the development of sheep husbandry in the area. Present commercial use of the drainage is confined to livestock grazing.

Water chemistry samples were collected from Sixmile Creek during the summer of 1980. Sample analyses revealed that Sixmile Creek is a calcium-magnesium-bicarbonate water of moderately alkaline pH. Specific conductance, hardness, alkalinity and concentrations of dissolved ions were higher than average for Mount Haggin streams. Water quality was generally good, although a slight elevation in arsenic was noted. The source of the arsenic is believed to be precipitates from the Anaconda Smelter. The lower reaches of Sixmile Creek exhibit eroded streambanks from past livestock grazing. Areas of channel instability exist in the vicinity of the Mule Ranch.

3. FISHERIES

A 1,000 foot section of Sixmile Creek was electrofished on August 7 and August 26, 1980. Game fish captured in descending order of abundance were brook trout, rainbow trout, cutthroat trout and rainbow X cutthroat hybrid trout. The mottled sculpin was the only nongame species collected. Electrofishing survey data are presented in Table 20.

Table 20. Summary of electrofishing survey for a 1,000 foot section of Sixmile Creek (T3N, R12W, Sec 25 A) on August 7 and August 26, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	189	1.0 - 9.7
Rainbow Trout	19	3.7 - 7.0
Cutthroat Trout	3	4.8 - 8.2
Rainbow X Cutthroat Hybrid Trout	2	5.4 - 9.5

Standing crops of brook and rainbow trout in the study section were estimated using a mark-recapture method (Table 21). The section supported approximately 392 brook trout and 20 rainbow trout representing a combined biomass of 14 pounds. Catchable fish (6 inches and longer) represented 9 percent of the brook trout population while 85 percent of the population was less than 5 inches and 66 percent of the population was less than 3 inches in length. Brook trout condition (length to weight ratio) was above average for Mount Haggin streams and other upper Big Hole River tributaries (MDFWP unpublished data).

Table 21. Estimated standing crops of brook and rainbow trout in a 1,000 foot section of Sixmile Creek (T3N, R12W, Sec 25A) on August 7, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Pounds
Brook Trout	1.0 - 2.9	259	
	3.0 - 4.9	76	
	5.0 - 6.9	34	
	7.0 - 9.7	23	
		392(±119)	13(±2)
Rainbow Trout	3.5 - 7.0	20	
		20(±3)	1(±0)

A 150 foot section of Sixmile Creek (T3N, R12W, Sec 24) was electrofished in 1976 (MDFWP unpublished data). Nine brook trout and single specimens of rainbow, cutthroat and rainbow X cutthroat hybrid trout were captured. The fish ranged in size from 2.7 to 8.4 inches in length. The survey rated the

fishery potential of Sixmile Creek as fair and noted that the cutthroat trout specimens appeared to be of the west slope variety.

Fishery data from the Sixmile Creek study section indicate that the stream may be an important rearing area for the California-French Creek drainage. The presence of small numbers of cutthroat leads to the possibility that larger populations may exist in other portions of the stream. Such populations would add to the importance of the fishery of Sixmile Creek.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected in a 165 foot riffle-run sequence located approximately at stream mile .5 (T3N, R12W, Sec 25A). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 21.5, 6.6, 3.2 and 1.8 cfs.

The relationships between wetted perimeter and discharge for a composite of four riffle cross sections is shown in Figure 8. Lower and upper inflection points occur at 2 and 4 cfs. Based on an evaluation of the existing fishery and recreational use potential, a flow of 2.5 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Sixmile Creek.

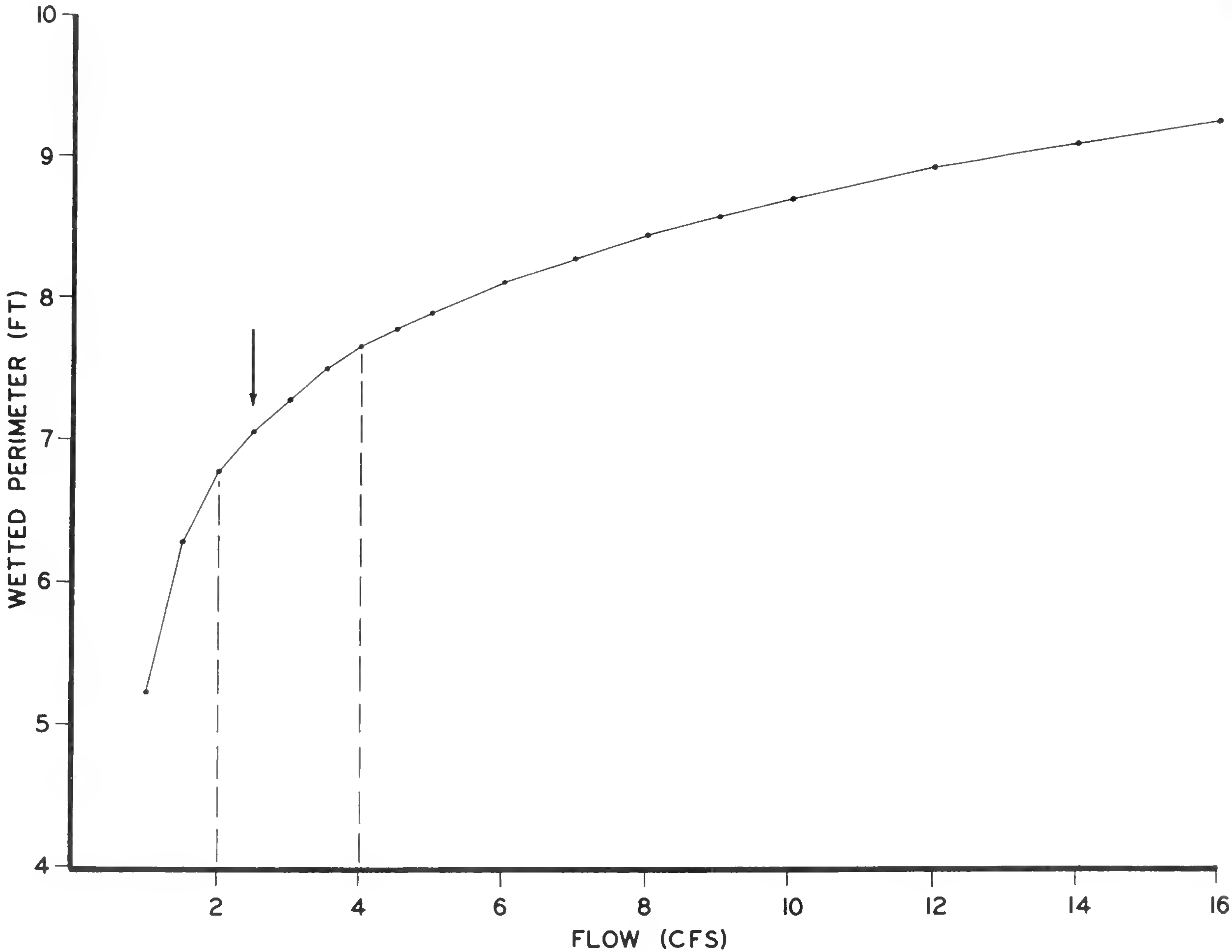


Figure 8. The relationship between wetted perimeter and flow for a composite of four riffle cross-sections in Sixmile Creek.

1. STREAM

Slaughterhouse Creek

2. DESCRIPTION

Slaughterhouse Creek originates in the timbered foothills of the east slope of the Anaconda-Pintlar Range. The stream flows in a southerly direction for approximately 4.2 miles to its confluence with Deep Creek, a tributary of the Big Hole River. The major tributary of Slaughterhouse Creek is Corral Creek. The 5.4 square mile drainage is characterized by steep heavily timbered slopes in the upper reaches and the broad Deep Creek floodplain at lower elevations. The stream is bordered by coniferous growth, primarily lodgepole pine, in the upper drainage and a broad riparian zone of willow, grasses and sedges in the Deep Creek floodplain. The average gradient of the 5.9 foot wide channel is 46.9 feet per 1,000 feet. The majority of the Slaughterhouse Creek drainage lies within the boundaries of the Deerlodge National Forest and the lower portions of the drainage are controlled by the MDFWP.

Lands within the Slaughterhouse Creek drainage are utilized for recreational hunting, fishing, trapping and winter sports. The broad willow bottoms of the lower Slaughterhouse Creek drainage and its Deep Creek floodplain constitute important winter range for moose. No estimate of fishing pressure is available for Slaughterhouse Creek and no fishermen use was observed during the summer of 1980. Past and present commercial uses of the drainage include livestock grazing and timber harvest.

Chemical analyses were performed on water samples collected from Slaughterhouse Creek during the summer of 1980. The data indicated that Slaughterhouse Creek is a calcium-magnesium-bicarbonate water of slightly basic pH. Specific conductance, alkalinity, hardness and nitrate concentration were much higher than average for other Mount Haggin streams resulting in a chemically rich water of good quality. Some streambank erosion from cattle grazing was noted in the lower reaches of Slaughterhouse Creek. Timber harvest in the upper reaches of Slaughterhouse and Corral Creeks could have an environmental impact through increased sedimentation.

3. FISHERIES

A 1,000 foot section of Slaughterhouse Creek was electrofished on August 13 and August 21, 1980. Game fish collected in descending order of abundance were brook trout and rainbow trout. Mottled sculpins and longnose suckers were the only nongame species collected. Electrofishing survey data are summarized in Table 22.

Table 22. Summary of electrofishing survey for a 1,000 foot section of Slaughterhouse Creek (T3N, R12W, Sec 34C) on August 13 and August 21, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	173	2.3 - 10.3
Rainbow Trout	1	6.8
Mottled Sculpin	-	-
Longnose Sucker	-	-

The standing crop of brook trout in the study section was estimated using a mark-recapture method (Table 23). The section supported approximately 182 fish representing a biomass of 19 pounds. Catchable fish (6 inches and longer) amounted to 42 percent of the population. Brook trout condition (length to weight ratio) was good and slightly above average for Mount Haggin streams and other upper Big Hole River tributaries (MDFWP, unpublished data). Data from the study section indicate that Slaughterhouse Creek has a good fishery relative to the size of the stream.

Table 23. Estimated standing crop of Brook trout in a 1,000 foot section of Slaughterhouse Creek (T3N, R12W, Sec 34C) on August 13, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Group (inches)	Per 1,000 ft. Number	Per 1,000 ft. Pounds
Brook Trout	3.5 - 6.9	130	
	7.0 - 10.3	52	
		182($\pm$28)	19($\pm$2)

4. FLOW RECOMMENDATIONS

Cross sectional data were collected in a 165 foot riffle-run sequence located approximately at stream mile .2 (T3N, R12W, Sec 34C). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 8.7, 5.0 and 1.8 cfs.

The relationship between wetted perimeter and discharge for a composite of three riffle cross sections is shown in Figure 9. Lower and upper inflection points occur at 2 and 4.5 cfs. Based on an evaluation of the existing fishery and recreational use potential, a flow of 3 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived for Slaughterhouse Creek.

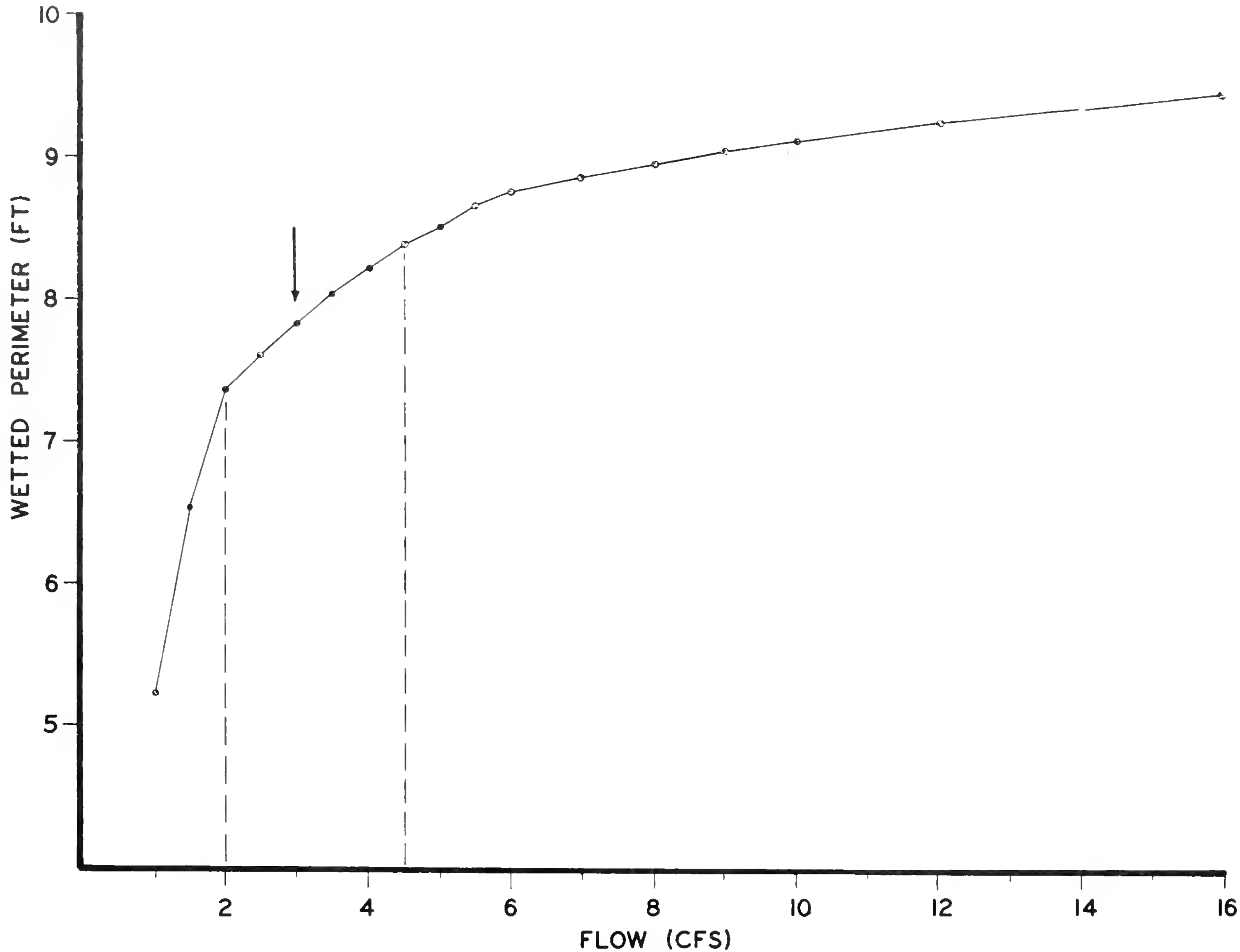


Figure 9. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in Slaughterhouse Creek.

1. STREAM

Sullivan Creek

2. DESCRIPTION

Sullivan Creek originates on the east slope of the Anaconda-Pintlar Range at the Continental Divide. The stream flows in a southerly direction for approximately 10.4 miles to its juncture with Deep Creek, a tributary of the Big Hole River. The major tributary of Sullivan Creek is Bear Trap Gulch Creek. The 9.7 square mile drainage is characterized by high alpine meadows, and small lakes, steep heavily timbered slopes, and relatively broad willow bottoms as the elevation decreases. The major vegetation types are coniferous forest in the upper reaches and willow-grass-sedge riparian zone at lower elevations. Numerous channels and beaver ponds characterize the stream in the lower riparian region. The average gradient of the 14.3 foot wide channel is 60.8 feet per 1,000 feet. The majority of the Sullivan Creek drainage is owned by the USFS with smaller portions under MDFWP and private control.

Lands within the Sullivan Creek drainage are used for recreational hunting, fishing, trapping, camping and winter sports. The willow bottom riparian zone is considered to be important moose winter range (Mike Frisina, personal communication). No estimate of fishing pressure is available for Sullivan Creek; however, some fishermen use was observed. Past commercial uses of the drainage include timber harvest, livestock grazing and diversion of water for irrigation. Present commercial uses include livestock grazing and heavy timber harvest in the upper drainage.

Chemical analyses were performed on water samples collected during the summer of 1980. The data revealed that Sullivan Creek has excellent water quality marked by very low specific conductance, alkalinity, hardness, suspended sediment and concentrations of dissolved ions. The stream is a weak calcium-magnesium-bicarbonate water of nearly neutral pH. Timber harvest and road construction in the upper reaches of the drainage could impair water quality in Sullivan Creek through sedimentation.

3. FISHERIES

A 1,000 foot section of Sullivan Creek was electrofished on August 6 and August 20, 1980. Brook trout and mottled sculpins were the only game and nongame species collected in the section. Electrofishing survey data are presented in Table 24.

Table 24. Summary of electrofishing survey for a 1,000 foot section of Sullivan Creek (T2N, R12W, Sec 32A) on August 6 and August 20, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	375	2.3 - 9.5
Mottled Sculpin	-	-

The standing crop of brook trout in the study section was estimated using a mark-recapture method (Table 25). The section supported approximately 602 fish representing a biomass of 29 pounds. Catchable fish (6 inches and longer) amounted to 12 percent of the population. Brook trout condition (length to weight ratio) was average for Mount Haggin streams and other upper Big Hole River tributaries (MDFWP unpublished data).

Table 25. Estimated standing crop of brook trout in a 1,000 foot section of Sullivan Creek (T2N, R12W, Sec 32A) on August 6, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Range (inches)	Per 1,000 ft. Number	Per 1,000 ft. Pounds
Brook Trout	2.5 - 3.9	258	
	4.0 - 6.9	324	
	7.0 - 9.5	19	
		602(±63)	29(±3)

Sullivan Creek supported the secondhighest brook trout population of all Mount Haggin streams surveyed; however, fish numbers were heavily concentrated in the small size groups. Analysis of scale samples indicated that brook trout growth was slightly slower than in other Mount Haggin streams although fish condition was about average. A 50 foot section of Sullivan Creek (T3N, R12W, Sec 30) was electrofished in 1976 (MDFWP unpublished data). Twenty-one brook trout ranging in size from 2.8 - 8.0 inches were captured. As a result of this survey, the fishery potential of Sullivan Creek was rated as good.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected from a 74 foot riffle-run-pool sequence located approximately at stream mile 2.6 (T2N, R12W, Sec 29CD). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 50.1, 19.4 and 5.1 cfs.

The relationship between wetted perimeter and discharge for a composite of two riffle cross sections is shown in Figure 10. Lower and upper inflection points occur at 4 and 5 cfs. Based on an evaluation of the existing fishery, recreational use potential and contributory flow to the Big Hole River, a flow of 4 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived.

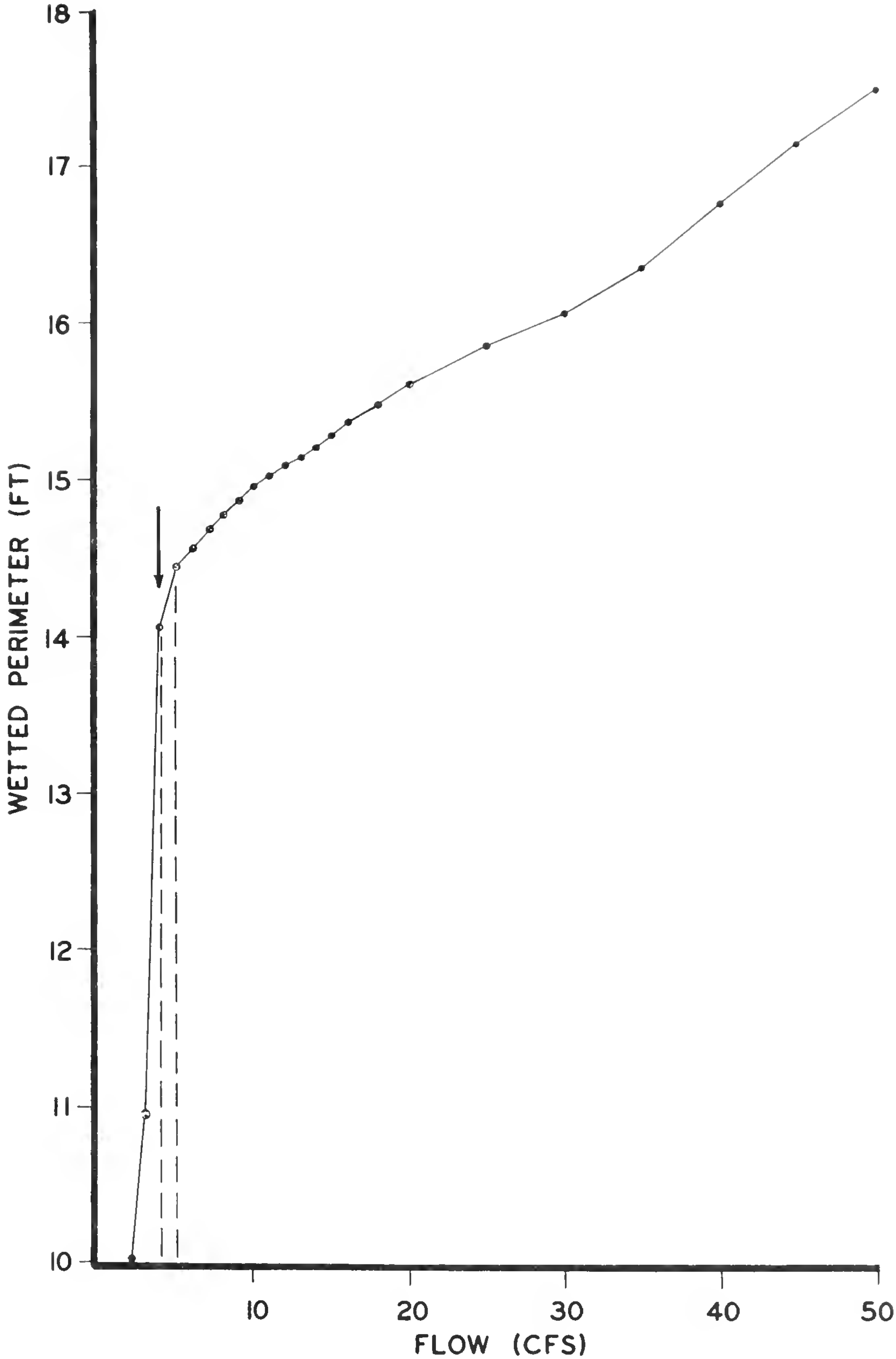


Figure 10. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in Sullivan Creek.

1. STREAM

Tenmile Creek

2. DESCRIPTION

Tenmile Creek originates on the east slope of the Anaconda-Pintlar range at the Continental Divide. The stream flows in a southerly direction for approximately 9.1 miles to its juncture with Sevenmile Creek to form Deep Creek and has no major tributaries. The 9.6 square mile drainage is characterized by high alpine meadows, timbered slopes and ridges, and broad willow bottoms as the elevation decreases. The alpine portion of the drainage contains numerous mountain lakes. Predominant vegetation types are coniferous forest in the upper reaches and a willow-grass-sedge riparian zone in the lower reaches. Numerous beaver ponds are found in the lower riparian region. The average gradient of the 12.3 foot wide channel is 57.9 feet per 1,000 feet. The majority of the Tenmile Creek drainage lies within the Deerlodge National Forest while the lower portions of the drainage are controlled by MDFWP.

Lands within the Tenmile Creek drainage are used for recreational hunting, fishing, trapping, backpacking, camping and winter sports. The lower riparian zone is considered to be important moose winter range. No estimate of fishing pressure is available for Tenmile Creek; however, some fishermen use was observed during the summer of 1980. Past commercial uses of the drainage include timber harvest, livestock grazing and diversion of water. Present commercial uses of the drainage include livestock grazing, timber harvest and commercial guiding and outfitting.

Chemical analyses were performed on water samples collected from Tenmile Creek during the summer of 1980. The data revealed that the stream has excellent water quality marked by very low specific conductance, alkalinity, hardness, suspended sediment and concentrations of dissolved ions. The stream is a weak calcium-sodium-bicarbonate water of nearly neutral pH.

3. FISHERIES

A 1,000 foot section of Tenmile Creek was electrofished on August 12 and August 21, 1980. Game fish captured in descending order of abundace were brook trout, rainbow trout and burbot. Mottled sculpins were the only nongame species present. Electrofishing survey data are summarized in Table 26.

Table 26. Summary of electrofishing survey for a 1,000 foot section of Tenmile Creek (T3N, R12W, Sec 34B) on August 12 and August 21, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	221	2.0 - 10.9
Rainbow Trout	3	4.3 - 7.7
Burbot	1	8.8
Mottled Sculpin	-	-

The standing crop of brook trout in the study section was estimated using a mark-recapture method (Table 27). The section supported approximately 353 fish representing a biomass of 31 pounds. Catchable fish (6 inches and longer) composed 32 percent of the population. Brook trout condition (length to weight ratio) was the highest of all Mount Haggin streams surveyed and was well above average for other upper Big Hole River tributaries (MDFWP, unpublished data).

Table 27. Estimated standing crop of brook trout in a 1,000 foot section of Tenmile Creek (T3N, R12W, Sec 34B) on August 12, 1980. Eighty percent confidence intervals are in parentheses.

		Per 1,000 ft.	
Species	Length Range (inches)	Number	Pounds
Brook Trout	3.0 - 4.9	179	
	5.0 - 6.9	117	
	7.0 - 10.9	57	
		353($\pm$57)	31$\pm$5)

A 1,000 foot section of Tenmile Creek (T3, R12W, Sec 22) was electrofished in 1976 (MDFWP unpublished data). Eleven brook trout ranging in size from 4.5 to 8.5 inches and 5 cutthroat trout ranging from 6.3 - 8.4 inches were collected during the survey. The study section surveyed during the 1976 inventory was located further upstream than the section that was electrofished in the present study. This may explain the lack of cutthroat trout in the present study section. Cutthroat trout and rainbow X cutthroat hybrid trout are known to occupy the Tenmile lakes at the headwaters of the drainage (MDFWP unpublished data).

Tenmile Creek was found to support a very good brook trout fishery relative to most other Mount Haggin streams. Numbers of catchable fish, brook trout condition, average weight and biomass were well above average for Mount Haggin streams.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected from a 266 foot riffle-run sequence located approximately at stream mile .3 (T3N, R12W, Sec 34B). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 44.0, 18.4 and 5.9 cfs.

The relationship between wetted perimeter and discharge for a composite of three riffle cross sections is shown in Figure 11. Lower and upper inflection points occur at 4 and 6 cfs. Based on an evaluation of the existing fishery, recreational use potential and contribution to downstream water quality and quantity in the Big Hole River, a flow of 6 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived.

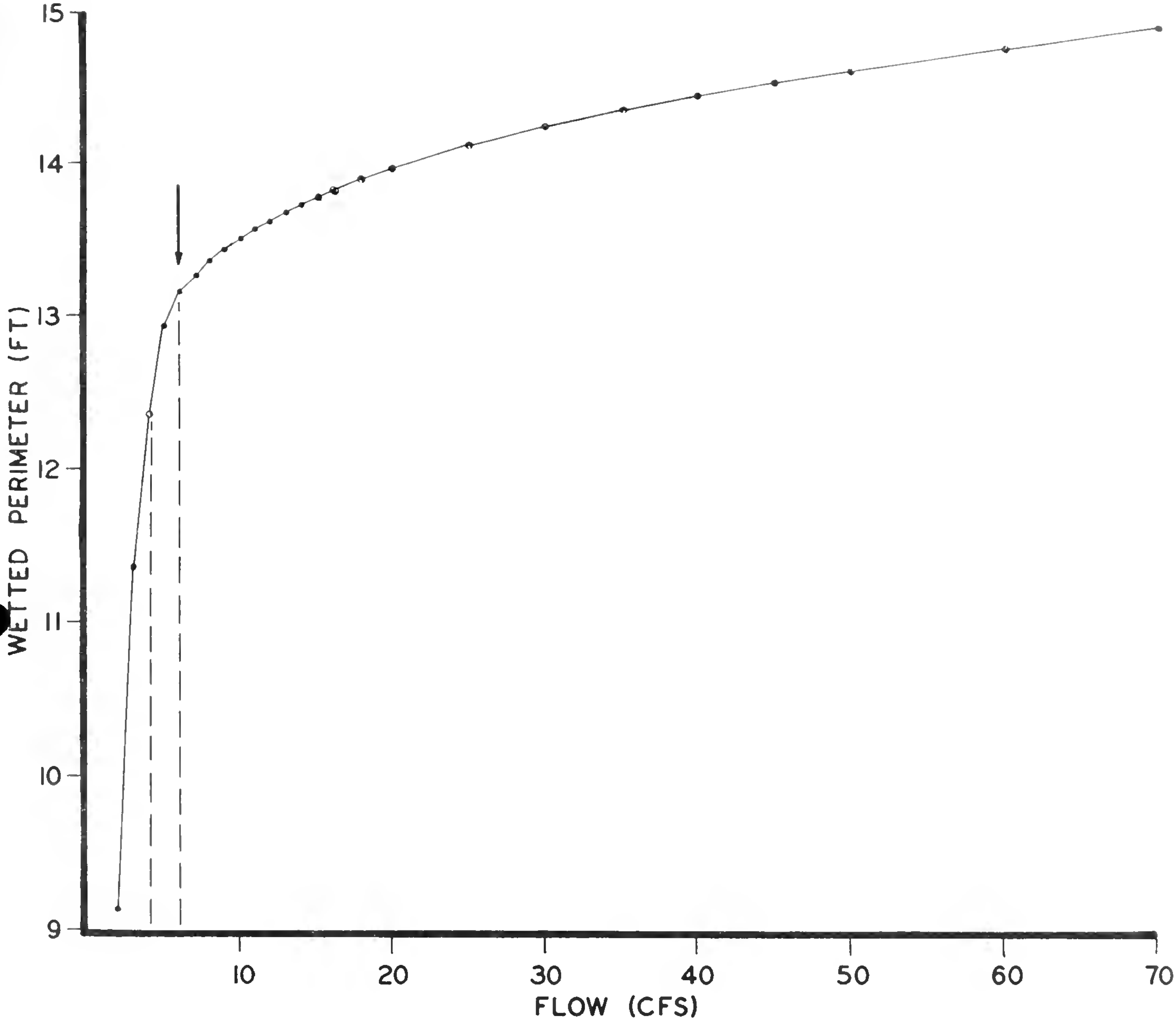


Figure 11. The relationship between wetted perimeter and flow for a composite of three riffle cross-sections in Tenmile Creek.

1. STREAM

Twelvemile Creek

2. DESCRIPTION

Twelvemile Creek originates on the east slope of the Anaconda-Pintlar range at the Continental Divide. The stream flows in a southerly direction for approximately 9.4 miles to its confluence with Deep Creek, a tributary of the Big Hole River. The only major tributary of Twelvemile Creek is the West Fork of Twelvemile Creek. The 10 square mile drainage area is characterized by high alpine meadows with numerous small lakes, timbered ridges and slopes, and broad willow bottoms as elevation decreases. The stream drops rapidly through coniferous forests in the upper reaches and meanders through a broad willow-grass-sedge- riparian zone in the Deep Creek floodplain. The lower willow bottoms are characterized by numerous beaver ponds. The average gradient of the 9.5 foot wide channel is 56.4 feet per 1,000 feet. Ownership majority of the Twelvemile Creek drainage is controlled by the USFS while a smaller portion is controlled by the MDFWP.

Lands within the Twelvemile Creek drainage are used for recreational hunting, fishing, trapping, and winter sports. Lower portions of the drainage contain important moose winter range and an elk calving area. No estimate of fishing pressure is available for Twelvemile Creek; however, some fishermen use was observed during the summer of 1980. Past commercial uses of the drainage include livestock grazing, timber harvest and diversion of water for irrigation. Present commercial uses include cattle grazing and timber harvest.

Chemical analyses were performed on water samples collected from Twelvemile Creek during the summer of 1980. The data revealed that the stream has excellent water quality marked by very low specific conductance, alkalinity, hardness, suspended sediment and concentration of dissolved ions. The stream is a weak calcium-sodium-bicarbonate water of nearly neutral pH.

The streambank and riparian zones of Twelvemile Creek are relatively stable and in good condition. Activities that could impair water quality and damage habitat include timber harvest in the upper drainage and cattle grazing along the lower reaches of the stream.

3. FISHERIES

A 1,000 foot section of Twelvemile Creek was electrofished on August 6 and August 20, 1980. Game fish captured in descending order of abundance were brook and rainbow X cutthroat hybrid trout. Mottled sculpin were the only non-game species collected. Electrofishing survey data are summarized in Table 28.

Table 28. Summary of electrofishing survey for a 1,000 foot section of Twelvemile Creek (T2N, R12W, Sec 4A) on August 6 and August 20, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	272	2.0 - 9.6
Rainbow X Cutthroat Hybrid Trout	1	8.8
Mottled Sculpin	-	-

The standing crop of brook trout in the study section was estimated using a mark-recapture method (Table 29). The section supported approximately 314 fish representing a biomass of 27 pounds. Catchable fish (6 inches and longer) composed 35 percent of the population. Brook trout condition (length to weight ratio) was good and slightly below average for Mount Haggin streams and other tributaries of the upper Big Hole River (MDFWP unpublished data).

Table 29. Estimated standing crop of brook trout in a 1,000 foot section of Twelvemile Creek (T2N, R12W, Sec 4A) on August 6, 1980. Eighty percent confidence intervals are in parentheses.

Species	Size Range (inches)	Per 1,000 ft. Number	Per 1,000 ft. Pounds
Brook Trout	3.0 - 4.9	143	
	5.0 - 6.9	112	
	7.0 - 9.6	59	
		314(±33)	27(±3)

A 100 foot section of Twelvemile Creek (T3N, R12W, Sec 20) was electrofished in 1976 (MDFWP unpublished data). Six brook trout ranging in length from 2.0 to 10.0 inches were collected during the survey. As a result of this inventory, the fishery potential of Twelvemile Creek was noted as fair.

Twelvemile Creek was found to support a very good brook trout fishery relative to other streams in the Mount Haggin area. Numbers of catchable fish, average weight and brook trout biomass were above average for Mount Haggin streams. Twelvemile Creek supported the second highest number of fish 7.0 inches long and greater in the area.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected from a 232 foot riffle-run sequence located approximately at stream mile .75 (T2N, R12W, Sec 4A). Five cross sections were placed within this sequence. The WETP program was calibrated to field data collected at flows of 24.5, 16.9, 7.7 and 1.8 cfs.

The relationship between wetted perimeter and discharge for a composite of two riffle cross sections is shown in Figure 12. Lower and upper inflection points occur at 1.5 and 2.5 cfs. Based on an evaluation of the existing fishery and recreational use potential, a flow of 2.5 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendations for the high flow period (May 1 - June 30) cannot be derived.

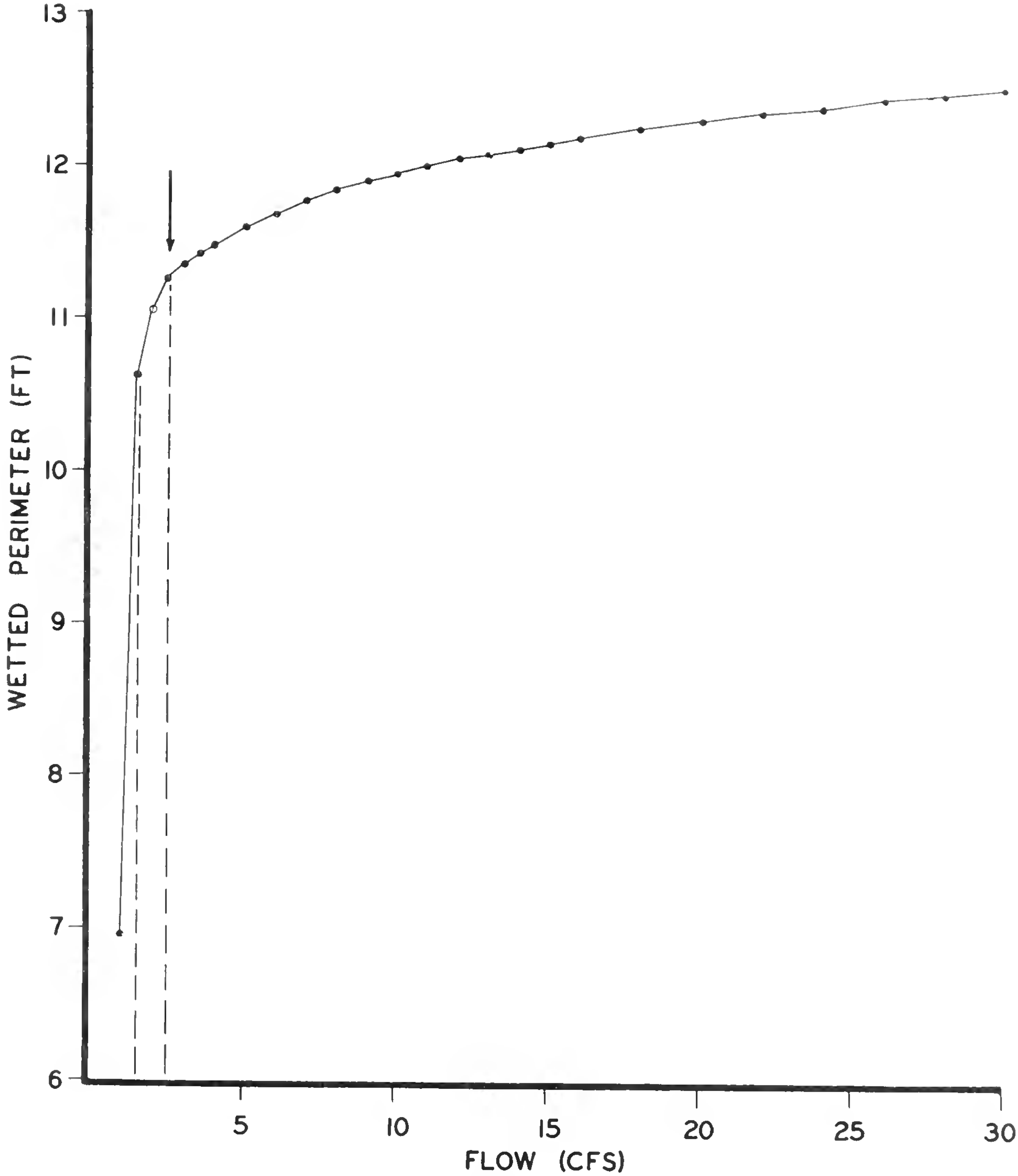


Figure 12. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in Twelvemile Creek.

1. STREAM

Willow Creek

2. DESCRIPTION

Willow Creek originates on the west slope of the Anaconda-Pintlar range at the Continental Divide. The stream flows in a northerly direction for approximately 12 miles to its juncture with Silver Bow Creek, a tributary of the Clark Fork of the Columbia River. Major tributaries of Willow Creek include Long Canyon, Elk and the West Fork of Willow Creek. The 26.5 square mile drainage is characterized by steep heavily timbered north-facing slopes, open grasslands, and agricultural lands as the elevation decreases. Headwater regions are vegetated with heavy coniferous growth and aspen thickets while lower regions are bordered by a narrow riparian zone of willow and alder and open grasslands. The upper forested region contains several revegetated clear-cuts and the riparian zone is marked by numerous beaver ponds. The average gradient of the 11 foot wide channel is 29.9 feet per 1,000 feet. Ownership of the upper drainage is held by MDFWP while the lower reaches of the stream are privately owned.

Lands within the Willow Creek drainage are used for recreational hunting, fishing and winter sports. The drainage contains areas of important deer and moose winter range (Frisina, personal communication). Fishing pressure on Willow Creek from May, 1975 to April 1976 was estimated at 560 fisherman days (MDFWP, 1976). This converts to approximately 47 fisherman days/stream mile/year. Past and present commercial uses of the drainage include timber harvest, livestock grazing and diversion of water for irrigation.

Chemical analyses were performed on water samples collected from Willow Creek during the summer of 1980. The data indicates that Willow Creek is a calcium-sodium-bicarbonate water of slightly basic pH. Specific conductance, alkalinity, hardness and dissolved solids were generally higher than values obtained from Mount Haggin streams that originate high on the east slope of the Anaconda-Pintlar range. Water quality was generally good with the exception of suspended sediment and dissolved arsenic levels. Elevated sediment levels were measured on the second day following a summer rain shower. The origin of the sediment is believed to be the eroded slopes in the vicinity of Sugarloaf Mountain. Arsenic levels were the highest measured in any Mount Haggin stream. A low flow concentration of 40.6 ug/l approached the maximum level of 50 ug/l accepted by the Environmental Protection Agency for drinking water (USEPA, 1976). The source of the arsenic is believed to be precipitates from the Anaconda Smelter.

3. FISHERIES

A 1,000 foot section of Willow Creek was electrofished on August 5 and August 19, 1980. Game fish captured in descending order of abundance were brook trout and cutthroat trout. Mottled sculpins and longnose suckers were the only nongame species collected. Electrofishing survey data are summarized in Table 30.

Table 30. Summary of electrofishing survey for a 1,000 foot section of Willow Creek (T4N, R10W, Sec 31B) on August 5 and August 19, 1980.

Species	No. Captured	Length Range (inches)
Brook Trout	494	1.5 - 9.3
Cutthroat Trout	54	3.3 - 9.2
Mottled Sculpin	-	-
Longnose Sucker	-	-

Standing crops of brook and cutthroat trout in the study section were estimated using a mark-recapture method (Table 31). The section supported approximately 677 brook trout and 63 cutthroat trout representing a combined biomass of 45 pounds. Catchable fish (6 inches and longer) composed 16 percent of the brook trout and 75 percent of the cutthroat populations. Brook trout condition (length to weight ratio) was below average for Mount Haggin streams.

Table 31. Estimated standing crops of brook and cutthroat trout in a 1,000 ft. section of Willow Creek (T4N, R10W, Sec. 31B) on August 5, 1980. Eighty percent confidence intervals are in parentheses.

Species	Length Range (inches)	Per 1,000 ft.	
		Number	Pounds
Brook Trout	3.5 - 4.9	364	
	5.0 - 6.4	262	
	6.5 - 9.3	50	
		677($\pm$73)	37($\pm$3)
Cutthroat Trout	3.8 - 6.9	37	
	7.0 - 9.2	26	
		63($\pm$10)	8($\pm$1)

The Willow Creek study section supported the highest numbers and biomass of trout of any of the Mount Haggin streams surveyed. It also supported the only population of cutthroat trout that was large enough to estimate. These

cutthroat appear to be of the Yellowstone variety and probably have replaced the native westslope variety as a result of stocking (Roscoe, unpublished data). The cutthroat trout population in the study section was composed mainly of larger fish (6 inches or longer) suggesting that reproducing populations of cutthroat may be found in otherportions of the stream or its tributaries.

4. FLOW RECOMMENDATIONS

Cross sectional data were collected from a 151 foot riffle-run-pool sequence located approximately at stream mile 7 (74N, R10W, Sec 31B). Five cross sections were placed within the sequence. The WETP program was calibrated to field data collected at flows of 27.2, 14.6 and 2.7 cfs.

The relationship between wetted perimeter and discharge for a composite of two riffle cross section is shown in Figure 13. Lower and upper inflection points occur at 5 and 8 cfs. Based on an evaluation of the existing fishery and recreational use, a flow of 6 cfs is recommended for the low flow period (July 1 - April 30). Due to a lack of long term flow data, recommendation for the high flow period (May 1 - June 30) cannot be derived.

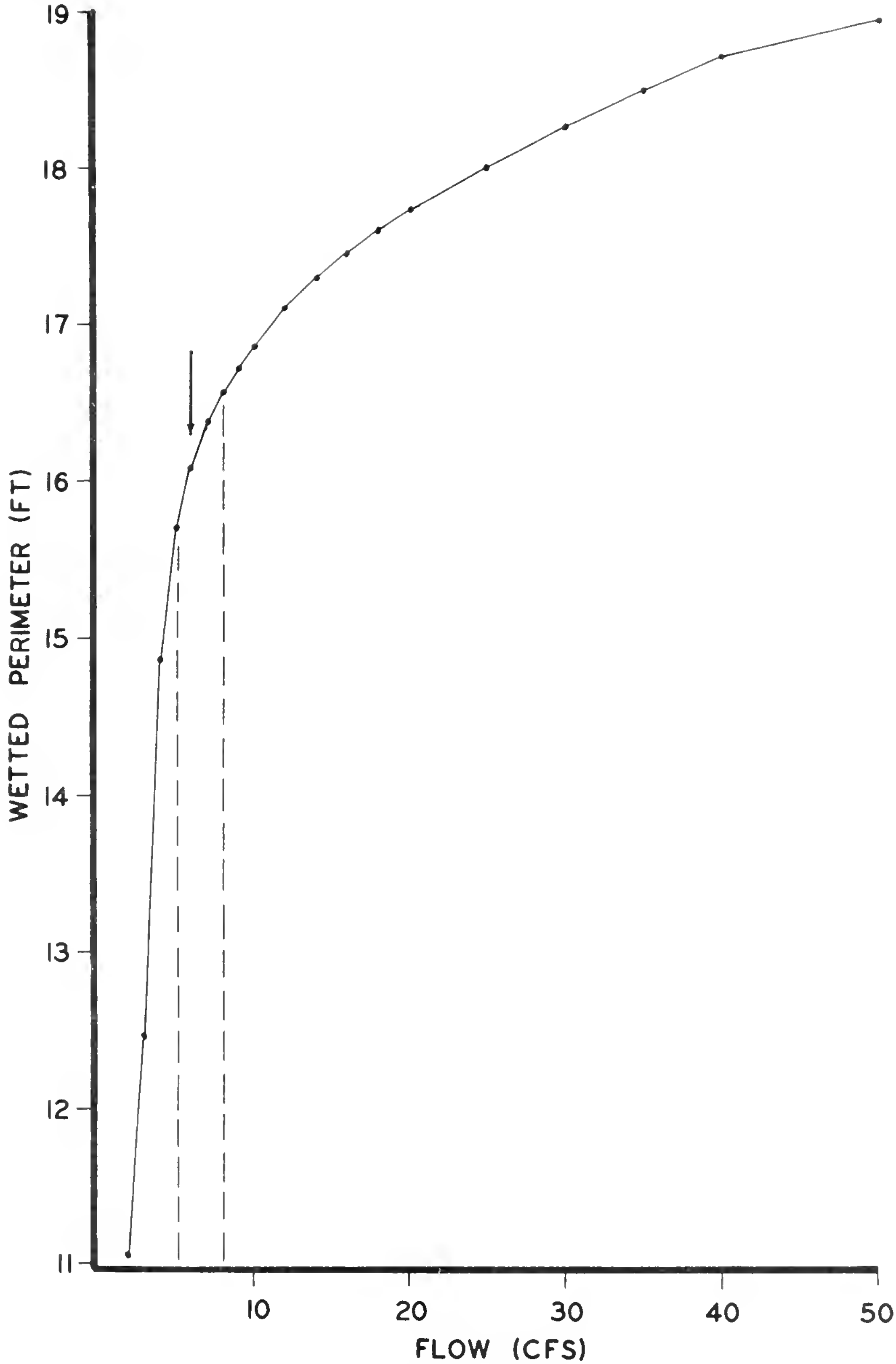
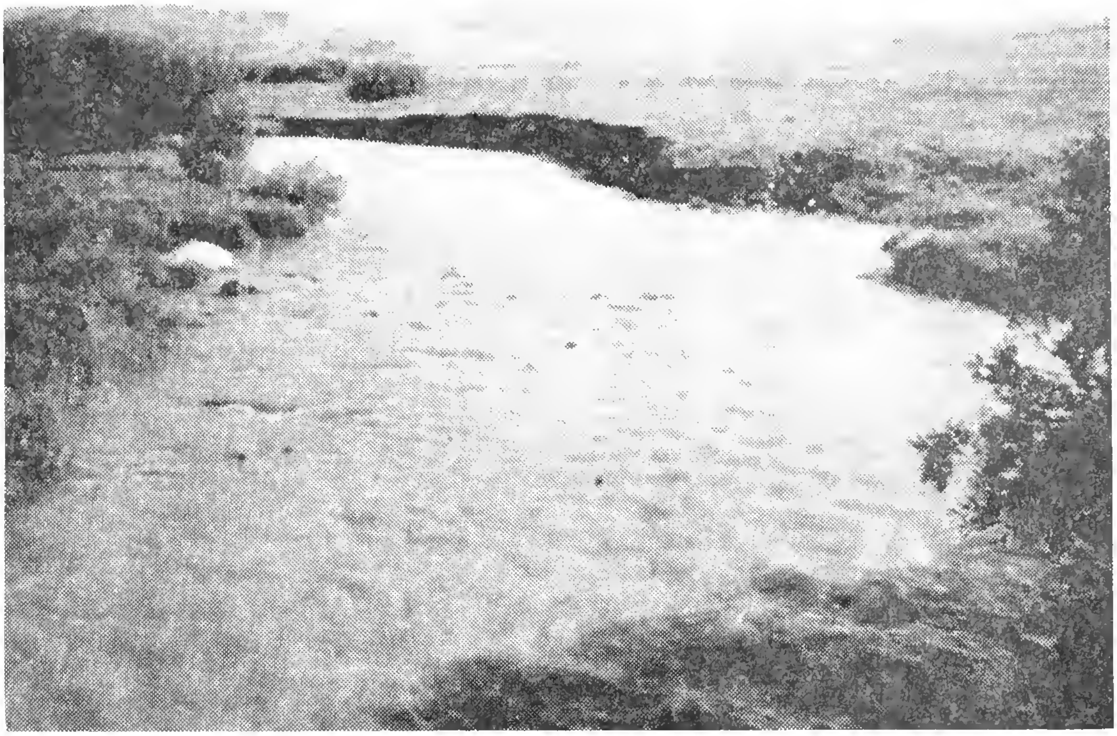


Figure 13. The relationship between wetted perimeter and flow for a composite of two riffle cross-sections in Willow Creek.



ENVIRONMENTAL CONCERNS

Environmental Concerns

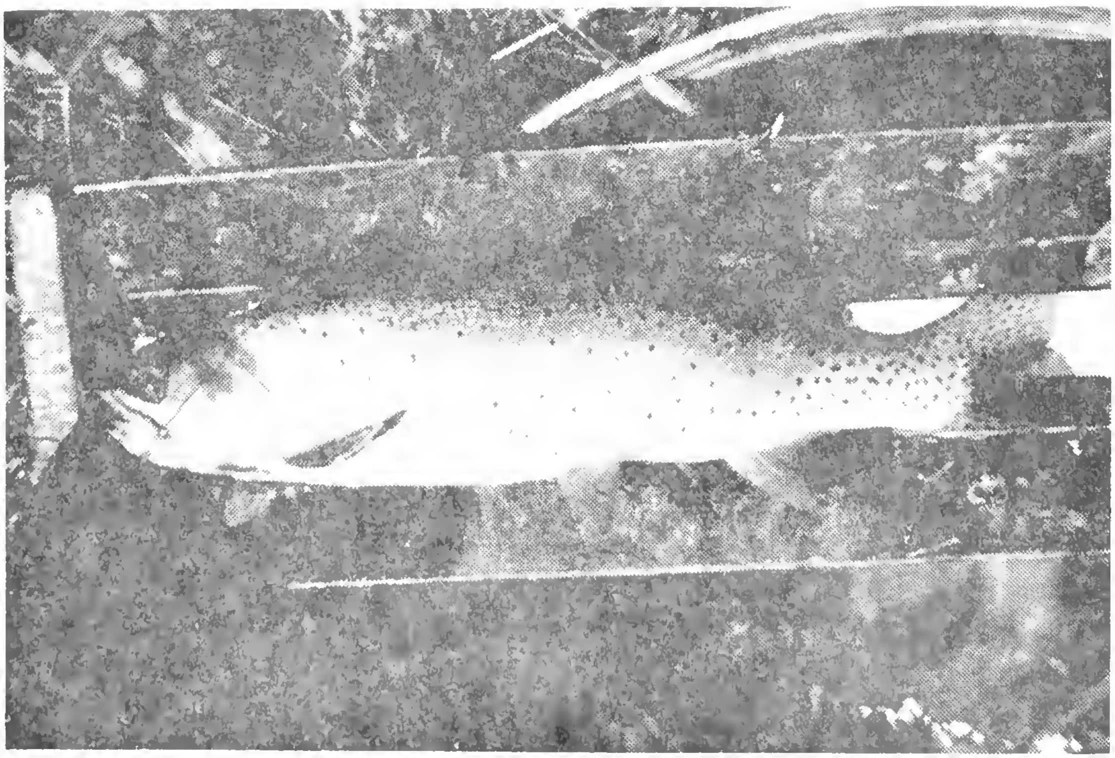
The Mount Haggin area was acquired for fish and wildlife management and multiple forms of outdoor recreation. The future management of the area calls for a return of lands to a more natural state. While the aquatic resource of the area appears to be in relatively good shape, certain areas of environmental concern should be addressed.

1) The area along the continental divide roughly located between Grassy and Sugarloaf Mountains has suffered from past practices. Intensive clear cutting, sheep grazing, fires and precipitates from the Anaconda Smelter have resulted in poorly vegetated land marked by heavily eroded hillsides. This area is the source of important headwater tributaries of Mill, Willow, Oregon, California and French Creeks. These slopes have been found to produce large amounts of sediment and iron into streams during runoff periods. The sediment and compounds of iron could be detrimental to downstream fisheries. Furthermore, the lack of shading from tree canopy could result in high summer water temperatures which may inhibit trout growth.

2) Water quality analysis detected elevated levels of some metals which are known to be detrimental to fish and other aquatic organisms. Concentrations of lead in Oregon Creek and mercury in California Creek approached levels found to be harmful to fish. Arsenic was found in relatively high concentrations in streams with past mining histories and streams subject to precipitates from the Anaconda Smelter. Although none of the concentrations of these metals exceeded EPA water quality standards, they do pose a potential threat to some of the Mount Haggin streams.

3) The grazing of livestock along Mount Haggin streams has been in practice since the mid-1880's and continues at present. Concentration of sheep and cattle along streams has resulted in numerous areas of streambank erosion and mass wasting. This problem is particularly evident along French and California Creeks. Livestock grazing practices have also been responsible for the chemical removal of much of the willow cover along these two streams. Unstable erodable banks and the loss of streambank and overhanging cover as a result of past livestock grazing practices may be acting to depress trout populations in California and French Creeks and in smaller reaches of other Mount Haggin streams.

4) Timber harvest began in the Mount Haggin drainages in 1883 and has persisted through the present day. Logging activities on national forest lands surrounding Mount Haggin could produce undesirable amounts of sediment into Mount Haggin streams. A current timber harvest contract between Louisana Pacific and MDFWP on the Mount Haggin property may also represent a potential threat to fisheries via sedimentation, elevated water temperatures, channel blockages and damage to riparian zones.



MANAGEMENT SUGGESTIONS

Management Suggestions

Based on evaluations of data collected during this study and on-site observations made during the field season, the following management suggestions are offered for the Mount Haggin streams.

1) Efforts should be made to encourage the reforestation and stabilization of the damaged slopes between Grassy and Sugarloaf Mountains. Livestock should be excluded from this important headwater region until the slopes become less erodable.

2) Minimum flows for fish and wildlife needs as recommended in this report should be secured and implemented.

3) Effects of the contracted timber harvest should be monitored on selected streams. A series of sediment and water temperature samples should be collected on a regular basis from established stations. Electrofishing surveys should be implemented to determine the effect of logging activities on fisheries if potentially harmful sediment or temperature levels are observed.

4) Cattle grazing along streams should be minimized. Cattle should be fenced from the immediate streambank and limited to small watering areas. The inventory of streambank, channel and riparian zone stability called for in the Interim Management Plan should be implemented to assess the current condition of the Mount Haggin streams and to establish a baseline from which to compare future recovery. A comparative study of channel stability and cover in relation to trout populations on California or Deep Creek would be of some value and should be considered for future implementation.

5) Concentrations of metals, particularly arsenic, lead and mercury should be monitored again in the future. In view of the closing of the Anaconda Smelter, it would be of some value to measure arsenic levels at a future date to monitor change. Heavy metals have been found at low levels in the water column yet have produced harmful effects on fish and invertebrates due to high concentrations in the sediments in Grasshopper Creek (Peterson, 1979). A heavy metals analysis of sediments in French and California Creeks may provide useful information and should be considered.

6) Additional fisheries work should be considered on the Mount Haggin streams. An electrofishing survey of the Deep Creek drainage should be undertaken to determine if a viable arctic grayling population still exists. If so, care should be taken to protect this species of special concern.

A further electrofishing survey should be conducted on Willow Creek to determine the size and extent of the cutthroat trout population. Care should be taken to preserve the habitat of this species.

A creel census should be implemented to determine the extent of fisherman use and exploitation. The Mount Haggin streams could provide an alternative fishery for people dissatisfied with the more restrictive harvest regulations on larger rivers.

Literature Cited

Bahls, L. L. 1978. Streamflow and water quality in the lower Big Hole River. Montana Department Health and Environ. Sciences, Helena, MT, 19 pp.

Bishop, C. G. 1951. Age, growth, and condition of trout in Prickly Pear Creek, Montana. Trans. Am. Micros. Soc., 74(2): 134-135.

Bovee, K. D. 1978. Probability of use criteria for the family Salmonidae. Cooperative Instream Flow Service Group, Fort Collins, Col. 80 pp.

Bowers, W., B. Hosford, A. Oakley, and C. Bond, 1979. Wildlife habitats in managed rangelands - the great basin of southeastern Oregon - native trout. Pacific Northwest Forest and Range Exp. Station, USFS, 16 pp.

Brown, C. J. D. 1971. Fishes of Montana. Big Sky Books, 207 pp.

Deacon, J.E., G. Kobetich, J.D. Williams and S. Contrevas. 1979. Fishes of North America endangered, threatened, or of special concern: 1979. Fisheries 4(2): 29-44.

Erickson. 1979. Big game survey and inventory Region Three. Montana Department Fish, Wildlife and Parks, Helena, Montana, Project No. W-130-R-10, Job No. I-3(c), 117 pp.

Frisina, M. R. 180. Mount Haggin big game study. Montana Department Fish, Wildlife and Parks, Helena, Montana. Project No. W-130-R-10, Job No. I-3.2, 83 pp.

Hynes, H. B. N. 170. The ecology of running waters. University of Toronto Press, 555 pp.

Liknes, G. A. 1981. The fluvial arctic grayling (<u>Thymallus arcticus</u>) of the upper Big Hole River drainage, Montana. Mstrs. Thesis, Montana State University, Bozeman, 59 pp.

Lyden, C. J. 1948. The gold placers of Montana. Montana Bureau of Mines and Geology, Butte, 152 pp.

McFadden, J. T. 1960. A population study of the brook trout, <u>Salvelinus fontinalis</u>, J. Penn. Ag. Exp. Sta., Paper No. 2437: 4-73.

Montana Department of Fish, Wildlife and Parks. 1976. Estimated man day of fishing pressure by region for the summer and winter season May, 1975 - April 1976. Montana Department Fish, Wildlife and Parks, Helena.

_______________. 1979. Instream flow evaluation for selected streams in the upper Missouri River basin. Montana Department Fish, Wildlife and Parks, Helena, 254 pp.

_______________. 1981. Instream flow evaluation for selected waterways in western Montana. Montana Department Fish, Wildlife and Parks, Ecological Services and Fisheries Divisions, Helena, USFS Contract No. 53-0343-0-305, 340 pp.

Nelson, F.A. 1980a. Evaluation of four instream flow methods applied to four trout rivers in southwest Montana. U.S. Fish and Wildlife Service, Contract No. 14-16-0006-78-046, 105 pp.

___________ 1980b. Guidelines for using the wetted perimeter (WETP) computer program of the Montana Department of Fish, Wildlife and Parks. Montana Department Fish, Wildlife and Parks, Helena, 23 pp.

Newell, A.S. 1980. Historic resources study Mount Haggin Area Deerlodge County, Montana. Historical Resource Associates, Missoula, Montana, 94 pp.

Peterson, N. W. 1979. Inventory of waters of the project area. Job progress report, Fed. Aid in Fish and Wildlife Restor. Acts, Project No. F-9-R-25, Job No. I-b, 23 pp.

Reid, G. K. and R. D. Wood. 1976. Ecology of inland waters and estuaries. D. Van Nostrand Co. 485 pp.

Ruttner, F. 1963. Fundamentals of limnology. University of Toronto Press, 295 pp.

Smith, M. B. 1979. Archeological investigations in the Deep Creek-French Creek locality Deerlodge County, Montana. Montana Department Fish, Wildlife and Parks, Helena, 67 pp.

U. S. Environmental Protection Agency. 1976. Quality criteria for water. USEPA, Cincinnati, Ohio, EPA-440/9-76-023, 501 pp.

Vincent, E. R. 1971. River electrofishing and population estimates. Prog. Fish Culturist, 33(3): 163-169.

___________ 1974. Addendum to river electrofishing and population estimates. Prog. Fish Culturist 36(3): 182.

Wipperman, A. H. 1965. Big Hole River Sport Fishery. Job. Comp. Report, Fed. Aid in Fish and Wildlife Rest. Acts, Proj. No. F-9-R-13 Job No. I-A, 10 pp.

___________. 1966. Effects of dewatering on a trout population. Job Comp. Report, Fed. Aid in Fish and Wildlife Restoration Acts, Proj. No. F-9-R-14, Job No. IV, 10 pp.

___________. 1967a. Inventory of the waters of the project area. Job Comp. Report, Fed. Aid in Fish and Wildlife Restoration Acts, Proj. No. F-9-R-15, Job No. I, 14 pp.

___________. 1967b. Effects of dewatering on a trout population. Job Comp. Report, Fed. Aid in Fish and Wildlife Restoration Acts, Proj. No. F-9-R-15, Job No. IV, 4 pp.

___________. 1968. Effects of dewatering on a trout population. Job Comp. Report, Fed. Aid in Fish and Wildlife Restoration Acts, Proj. No. F-9-R-16, Job No. IV, 9 pp.

A P P E N D I X

Appendix Table 1. Concentrations* of selected chemical and physical parameters measured in Mount Haggin streams at high, intermediate and low flows.

	Seymour Cr.			Sullivan Cr.			Twelvemile Cr.		
	High	Inter.	Low	High	Inter.	Low	High	Inter.	Low
Conductance	45.4	54.7	66.3	47.0	63.8	81.2	28.7	34.5	43.9
Alkalinity	17.14	21.32	31.25	12.63	16.98	36.25	7.71	11.07	18.62
Hardness	19.44	22.43	32.55	19.16	26.30	39.81	9.96	11.96	20.26
pH	7.10	7.16	7.75	6.79	7.16	7.59	6.59	6.96	7.28
Sediment	44.1	3.0	1.8	17.4	5.1	2.8	3.2	1.9	0.9
Temperature	6.0	14.0	9.0	8.0	16.5	14.0	14.0	16.0	15.0
Ca	6.3	7.5	10.4	5.2	7.4	11.0	3.0	3.8	6.3
Mg	0.9	0.9	1.6	1.5	1.9	3.0	0.6	0.6	1.1
Na	1.4	1.5	2.4	1.4	1.5	2.4	1.7	1.7	2.7
K	1.1	0.6	0.9	0.9	0.3	0.7	0.7	0.1	0.6
Fe	0.05	0.08	0.08	0.17	0.46	0.55	0.11	0.20	0.23
Mn	<0.01	0.01	<0.01	0.01	0.03	0.03	<0.01	0.01	0.01
SiO_2	8.8	10.5	13.7	9.0	10.8	12.9	9.9	10.6	13.8
HCO_3	20.9	26.0	38.1	15.4	20.7	44.2	9.4	13.5	22.7
CO_3	-	-	-	-	-	-	-	-	-
SO_4	4.9	3.6	4.0	8.6	6.9	6.3	4.6	2.5	3.4
Cl	0.8	0.1	0.2	0.9	0.5	0.3	0.7	0.4	0.8
NO_3	0.22	0.46	<0.01	0.20	0.15	<0.01	0.14	0.15	0.03
F	0.36	0.28	0.18	0.32	0.18	0.41	0.43	0.25	0.11
Total Fe	0.08	0.10	0.11	0.32	0.62	0.87	0.19	0.27	0.35
Total Mn	0.01	0.01	0.01	0.02	0.03	0.05	<0.01	0.01	0.02

*Concentrations in mg/l; conductance in umhos/cm; temperature in ^{o}C.

Appendix Table 1. Continued

	Slaughterhouse Cr.			Tenmile Cr.			Sevenmile Cr.		
	High	Inter.	Low	High	Inter.	Low	High	Inter.	Low
Conductance	142.8	173.8	199.2	35.3	36.3	51.5	218.8	205.9	282.9
Alkalinity	60.12	81.85	105.15	12.30	11.32	23.78	102.52	129.49	163.79
Hardness	64.86	84.45	106.84	15.10	14.03	22.99	109.36	133.68	166.78
pH	7.43	7.64	8.00	6.79	6.97	7.30	7.89	8.10	8.33
Sediment	4.2	2.5	4.0	3.7	8.8	1.0	4.5	10.9	2.9
Temperature	15.0	17.0	14.0	12.0	14.0	10.0	15.0	17.0	14.0
Ca	17.9	23.6	29.6	4.4	4.3	6.9	31.6	38.7	48.0
Mg	4.9	6.2	8.0	1.0	0.8	1.4	7.4	9.0	11.4
Na	3.2	3.3	4.2	2.1	1.6	2.6	2.5	2.4	3.0
K	1.2	0.6	0.7	0.6	<0.1	0.4	1.3	0.4	0.7
Fe	0.12	0.19	0.27	0.07	0.11	0.16	0.11	0.18	0.20
Mn	0.01	0.02	0.06	<0.01	0.01	0.01	0.01	0.02	0.01
SiO_2	18.0	19.5	18.1	9.2	9.0	11.8	14.7	16.0	15.2
HCO_3	73.3	99.8	128.2	15.0	13.8	29.0	125.0	153.0	199.7
CO_3	-	-	-	-	-	-	-	-	-
SO_4	9.2	5.6	5.5	6.6	2.5	3.5	11.5	6.4	3.0
Cl	0.6	0.3	0.7	0.7	0.4	0.5	1.0	0.2	0.3
NO_3	0.27	2.24	0.03	0.03	0.06	<0.01	0.10	2.22	<0.01
F	0.29	0.23	0.13	0.31	0.16	0.22	0.40	0.23	0.13
Total Fe	0.18	0.28	0.44	0.11	0.16	0.21	0.26	0.43	0.38
Total Mn	0.02	0.04	0.08	<0.01	0.01	0.02	0.02	0.04	0.02

*Concentraions in mg/l; conductance in wmhos/cm; temperature in ^{o}C

Appendix Table 1. Continued

	Deep Cr. High	Deep Cr. Inter.	Deep Cr. Low	Sixmile Cr. High	Sixmile Cr. Inter.	Sixmile Cr. Low	Oregon Cr. High	Oregon Cr. Inter.	Oregon Cr. Low
Conductance	54.6	69.2	95.3	165.8	213.0	233.3	84.2	99.5	104.4
Alkalinity	19.44	28.54	43.14	69.39	96.86	109.49	24.11	35.84	46.42
Hardness	23.98	30.46	45.22	80.15	103.01	114.56	31.04	36.11	46.38
pH	6.98	7.26	7.74	7.79	8.01	8.20	6.94	7.44	7.79
Sediment	19.9	3.3	2.4	18.9	1.5	2.9	28.9	5.5	3.7
Temperature	9.0	18.0	14.0	11.0	15.0	15.0	16.0	13.0	10.5
Ca	6.8	8.9	13.0	26.0	34.0	37.8	9.3	11.0	13.3
Mg	1.7	2.0	3.1	3.7	4.4	4.9	1.9	2.1	3.2
Na	2.0	1.9	2.8	1.9	1.7	2.5	4.8	5.5	5.2
K	1.1	0.2	0.7	1.1	0.4	0.8	1.5	0.9	1.5
Fe	0.16	0.26	0.38	0.12	0.13	0.08	0.10	0.18	0.17
Mn	0.01	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.02
SiO_2	11.0	11.8	13.3	12.0	13.0	11.6	19.6	20.8	16.4
HCO_3	23.7	34.8	52.6	84.6	118.1	133.5	29.4	43.7	56.6
CO_3	-	-	-	-	-	-	-	-	-
SO_4	7.3	4.1	3.0	12.4	7.8	7.6	14.4	8.9	9.3
Cl	0.6	0.2	0.3	0.6	0.2	1.2	0.7	0.3	0.4
NO_3	0.12	0.47	0.02	0.32	0.07	0.02	0.01	0.23	0.01
F	0.32	0.26	0.23	0.21	0.38	0.04	0.21	0.20	0.13
Total Fe	0.26	0.36	0.56	0.23	0.17	0.13	0.28	0.25	0.23
Total Mn	0.02	0.02	0.03	0.02	0.02	0.02	0.01	0.02	0.02

*Concentraions in mg/l; conductance in umhos/cm; temperature in $^{\circ}C$.

Appendix Table 1. Continued

	American Cr.			California Cr.			French Cr.		
	High	Inter.	Low	High	Inter.	Low	High	Inter.	Low
Conductance	103.2	122.3	125.6	118.3	145.0	171.9	104.0	132.0	172.9
Alkalinity	42.24	55.85	60.45	44.37	58.31	81.94	37.65	50.77	71.68
Hardness	47.60	58.80	64.19	49.88	62.07	84.21	42.99	53.61	73.43
pH	7.30	7.78	7.91	7.36	7.57	8.19	7.47	7.31	8.30
Sediment	3.5	3.5	1.8	8.1	235.8	4.5	9.1	98.3	4.9
Temperature	10.0	16.0	14.0	11.0	11.0	17.0	10.0	13.0	18.0
Ca	12.8	15.8	17.3	14.7	18.1	24.0	12.6	15.7	21.0
Mg	3.8	4.7	5.1	3.2	4.1	5.9	2.8	3.5	5.1
Na	1.7	1.7	1.8	3.5	3.3	3.1	3.5	3.5	3.6
K	1.9	1.1	1.3	1.5	3.4	1.1	1.5	1.3	1.4
Fe	0.07	0.10	0.13	0.12	0.18	0.17	0.13	0.15	0.08
Mn	<0.01	0.01	0.01	<0.01	0.02	0.01	0.01	0.02	<0.01
SiO_2	12.6	12.3	12.2	16.9	15.5	14.0	18.3	18.8	16.4
HCO_3	51.5	68.1	73.7	54.1	71.1	99.9	45.9	61.9	87.4
CO_3	-	-	-	-	-	-	-	-	-
SO_4	8.6	5.4	4.0	12.8	9.8	6.1	12.0	11.3	6.1
Cl	0.5	0.3	0.4	0.8	0.3	0.4	0.9	0.3	0.4
NO_3	0.02	0.06	0.04	0.11	0.20	<0.01	0.04	0.36	0.27
F	0.18	0.08	0.08	0.20	0.30	0.09	0.20	0.14	0.09
Total Fe	0.14	0.15	0.21	0.23	6.50	0.26	0.24	1.74	0.30
Total Mn	<0.01	0.01	0.02	0.02	0.15	0.20	0.01	0.06	0.02

*Concentrations in mg/l; conductance in umhos/cm; temperature in $^{\circ}C$.

Appendix Table 1. Continued.

	Willow Cr. High	Inter.	Low
Conductance	130.1	148.0	149.9
Alkalinity	34.61	44.62	56.51
Hardness	46.44	51.92	55.24
pH	7.33	7.53	7.62
Sediment	2.1	12.4	2.4
Temperature	14.0	12.0	12.0
Ca	15.3	17.0	18.0
Mg	2.0	2.3	2.5
Na	6.7	7.5	8.1
K	1.7	1.3	1.4
Fe	0.08	0.11	0.18
Mn	0.01	0.03	0.03
SiO_2	24.0	26.4	27.1
HCO_3	42.2	54.4	68.9
CO_3	-	-	-
SO_4	24.8	20.4	14.5
Cl	1.2	0.7	0.9
NO_3	0.02	0.11	<0.01
F	0.24	0.06	0.11
Total Fe	0.13	0.39	0.26
Total Mn	0.02	0.04	0.04

*Concentrations in mg/l; conductance in unhos/cm; temperature in $^{\circ}C$.

Appendix Table 2. Summaries of electrofishing surveys for 1,000 ft. section of Mount Haggin Area streams.

Seymour Creek (T2N, R13W, Sec 13D) August 11 and August 25, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	273	2.2 - 10.2
Mottled Sculpin	-	-

Sullivan Creek (T2N, R12W, Sec 32A) August 6 and August 20, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	375	2.3 - 9.5
Mottled Sculpin	-	-

Twelvemile Creek (T2N, R12W, Sec 4A) August 6 and August 20, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	272	2.0 - 9.6
Rainbow X Cutthroat Hybrid	1	8.8
Mottled Sculpin	-	-

Slaughterhouse Creek (T3N, R12W, Sec 34C) August 13 and August 21, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	173	2.3 - 10.3
Rainbow Trout	1	6.8
Longnose Sucker	2	6.6 - 8.4
Mottled Sculpin	-	-

Tenmile Creek (T3N, R12W, Sec 34B) August 12 and August 21, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	221	2.0 - 10.9
Rainbow Trout	3	4.3 - 7.7
Burbot	1	8.8
Mottled Sculpin	-	-

Appendix Table 2. Continued.

Sevenmile Creek (T3N, R12W, Sec 34A) August 12 and 21, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	149	2.1 - 10.1
Rainbow Trout	2	4.8 - 7.7
Rainbow X Cutthroat Hybrid	1	7.7
Longnose Sucker	3	6.5 - 8.1
Mottled Sculpin	-	-

Deep Creek (T2N, R12W, Sec 9A) August 26 and September 5, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	131	2.2 - 9.9
Rainbow Trout	12	2.5 - 11.0
Mountain Whitefish	6	8.4 - 13.1
Burbot	13	7.2 - 13.0
Longnose Sucker	25	-
Longnose Dace	-	-
Mottled Sculpin	-	-

Sixmile Creek (T3N, R12W, Sec 25A) August 7 and August 26, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	189	1.0 - 9.7
Rainbow Trout	19	3.7 - 7.0
Cutthroat Trout	3	4.8 - 8.2
Rainbow X Cutthroat Hybrid	2	5.4 - 9.5
Mottled Sculpin	-	-

Oregon Creek (T3N, R11W, Sec 20C) August 5 and August 14, 1981

Species	No. Captured	Length Range (inches)
Brook Trout	275	2.5 - 11.1
Rainbow Trout	4	4.6 - 8.3
Mottled Sculpin	-	-

Appendix Table 2. Continued.

American Creek (T3N, R11W, Sec 30C) August 7 and August 19, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	147	2.0 - 10.0
Rainbow Trout	8	6.4 - 9.2
Rainbow X Cutthroat Hybrid	1	9.5
Mottled Sculpin	-	-

California Creek (T2N, R12W, Sec 1B) August 4 and August 18, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	97	3.6 - 10.2
Rainbow Trout	23	2.4 - 8.9
Mountain Whitefish	9	6.8 - 12.6
Burbot	1	11.0
Longnose Sucker	29	4.8 - 12.1
Longnose Dace	-	-
Mottled Sculpin	-	-

French Creek (T2N, R12W, Sec 10C) July 11 and August 1, 1979*

Species	No. Captured	Length Range (inches)
Rainbow Trout	17	4.1 - 10.2
Brook Trout	13	5.5 - 10.4
Mountain Whitefish	9	8.3 - 11.5
Burbot	4	7.8 - 9.3
Longnose Sucker	48	4.1 - 11.0
Longnose Dace	-	-
Mottled Sculpin	-	-

Willow Creek (T4N, R10W, Sec 31B) August 5 and August 19, 1980

Species	No. Captured	Length Range (inches)
Brook Trout	494	1.5 - 9.3
Cutthroat Trout	54	3.3 - 9.2
Longnose Sucker	2	7.6 - 8.8
Mottled Sculpin	-	-

*Data from Jane Decker-Hess 1979 (MDFWP)

Appendix Table 3. Estimated standing crops of trout in 1,000 ft. study sections of Mount Haggin Area streams. Eighty percent confidence intervals are in parentheses.

Seymour Creek (T2N, R13W, Sec 13D) August 11, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.2 - 4.9	263	9
	5.0 - 6.9	177	15
	7.0 - 10.2	79	17
		519(±111)	41(±5)

Sullivan Creek (T2N, R12W, Sec 32A), August 6, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	2.5 - 3.9	258	6
	4.0 - 6.9	324	18
	7.0 - 9.5	19	5
		602(±63)	29(±3)

Twelvemile Creek (T2N, R12W, Sec 4A) August 6, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.0 - 4.9	143	5
	5.0 - 6.9	112	9
	7.0 - 9.6	59	13
		314(±33)	27(±3)

Slaughterhouse Creek (T3N, R12W, Sec 34C) August 13, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.5 - 6.9	130	8
	7.0 - 10.3	52	11
		182(±28)	19(±2)

Appendix Table 3. Continued.

Tenmile Creek (T3N, R12W, Sec 34B) August 12, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Pounds
Brook Trout	3.0 - 4.9	179	6
	5.0 - 6.9	117	11
	7.0 - 10.9	57	14
		353(+57)	31(+5)

Sevenmile Creek (T3N, R12W, Sec 34A) August 12, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Pounds
Brook Trout	3.0 - 4.9	83	3
	5.0 - 6.4	68	5
	6.5 - 10.1	31	5
		183(+29)	13(+2)

Deep Creek (T2N, R12W, Sec 9A) August 26, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Pounds
Brook Trout	4.0 - 6.9	129	10
	7.0 - 9.9	37	8
		166(+35)	18(+3)
Rainbow Trout	4.5 - 11.0	18	3
		18(+9)	3(+2)

Sixmile Creek (T3N, R12W, Sec 25A) August 7, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Pounds
Brook Trout	1.0 - 2.9	259	3
	3.0 - 4.9	76	3
	5.0 - 6.9	34	3
	7.0 - 9.7	23	5
		392(+119)	14(+2)
Rainbow Trout	3.5 - 7.0	20	1
		20(+3)	1(+0)

Appendix Table 3. Continued

Oregon Creek (T3N, R11W, Sec 20C) August 5, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.5 - 6.9	221	15
	7.0 - 11.1	44	9
		265(±28)	24(±3)

American Creek (T3N, R11W, Sec 30C) August 7, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.2 - 5.9	122	6
	6.0 - 10.0	88	6
		160(±24)	12(±1)
Rainbow Trout	6.0 - 9.2	8	1
		8(±3)	1(±0)

California Creek (T2N, R12W, Sec 1B) August 4, 1980

Species	Length Range (inches)	Per 1,000 Ft. Number	Per 1,000 Ft. Pounds
Brook Trout	3.6 - 6.9	86	7
	7.0 - 10.2	44	9
		130(±20)	16(±2)
Rainbow Trout	3.9 - 8.9	30	3
		30(±10)	3(±1)

Appendix Table 3. Continued.

Willow Creek (T4N, R10W, Sec 31B) August 5, 1980.

Species	Length Range (inches)	Per 1,000 Ft. Number	Pounds
Brook Trout	3.5 - 4.9	364	11
	5.0 - 6.4	262	19
	6.5 - 9.3	50	7
		677($\pm$73)	37($\pm$3)
Cutthroat Trout	3.8 - 6.9	37	3
	7.0 - 9.2	26	4
		63($\pm$10)	8($\pm$1)